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September 9, 2016

James W. Parker, Chair
Board of Environmental Protection
c/o Ruth Ann Burke
17 State House Station
Augusta, ME 04333-0017

Re: Juniper Ridge Landfill Expansion
DEP #S-020700-WD-BI-N and #L-024251-TG-C-N

Dear Chairman Parker:

On behalf of the Bureau of General Services (BGS) and NEWSME Landfill Operations, LLC (NEWSME), I am attaching the Pre-filed Rebuttal Testimony of BGS and NEWSME in this proceeding.

Thank you very much for your continued attention to this matter.

Very truly yours,

Tom Doyle

Thomas R. Doyle

Enclosure
cc: Service List (via email and U.S. Mail)

STATE OF MAINE
DEPARTMENT OF ENVIRONMENTAL PROTECTION

IN THE MATTER OF

BUREAU OF GENERAL SERVICES	)
NEWSME LANDFILL OPERATIONS, LLC	)
JUNIPER RIDGE LANDFILL EXPANSION	)
OLD TOWN AND ALTON, PENOBSCOT	)
COUNTY, MAINE	)
# S-020700-WD-BI-N and #L-024251-TG-C-N	)

PRE-FILED REBUTTAL TESTIMONY

of

BUREAU OF GENERAL SERVICES (BGS)

and

NEWSME LANDFILL OPERATIONS, LLC (NEWSME)

SEPTEMBER 9, 2016

EXHIBIT LIST FOR PRE-FILED REBUTTAL TESTIMONY
OF BUREAU OF GENERAL SERVICES AND
NEWSME LANDFILL OPERATIONS, LLC

Toni M. King

MRC-Fiberight DEP License .... BGS/NEWSME #48
ReEnergy Annual Report .... BGS/NEWSME #49
ARC Annual Report .... BGS/NEWSME #50

John E. Sevee

Michael S. Booth

Storage Volume for Cell 12 Leachate Sump .... BGS/NEWSME #51
September 2015 Leachate Flow Data .... BGS/NEWSME #52
HELP Model Outputs .... BGS/NEWSME #53
Bangor Daily News June 25, 2012 Article on the Brownville Storm .... BGS/NEWSME #54
Rainfall amounts for 2003 and September 30, 2015 .... BGS/NEWSME #55
Figure Showing Flood Plain Elevations .... BGS/NEWSME #56

Bryan P. Emerson

DMR/IFW Comments Re Atlantic Salmon .... BGS/NEWSME #57
Stream Buffers .... BGS/NEWSME #58
Setbacks Castelle Wetland and Stream Buffer Size Requirements 1994 .... BGS/NEWSME #59
Wilkerson et al 2006 The Effectiveness of Different Widths for
Protecting Headwater Stream Temperatures in Maine .... BGS/NEWSME #60
MIFW Forest Management Recommendations for Brook Trout .... BGS/NEWSME #61
Army Corps of Engineers Compensatory Mitigation Guidance,
Relevant Pages .... BGS/NEWSME #62

Jeremy M. Labbe

Pages, January 2016 Maine Solid Waste Generation and Disposal
Capacity Report .... BGS/NEWSME #63
Pages from Chapter 400 .... BGS/NEWSME #64
Waste Weight Ticket Juniper Ridge Landfill .... BGS/NEWSME #65
August 1, 2016 Letter to MEDEP with OBW Breakdown .... BGS/NEWSME #66
Complaint Record Form Juniper Ridge Landfill .... BGS/NEWSME #67
Odor School Certificate .... BGS/NEWSME #68

King, Toni M.

PRE-FILED REBUTTAL TESTIMONY OF TONI M. KING
BEFORE THE BOARD OF ENVIRONMENTAL PROTECTION
REGARDING DIRECT TESTIMONY OF EDWARD S. SPENCER
JUNIPER RIDGE LANDFILL EXPANSION
DEP APPLICATIONS #S-020700-WD-BI-N & #L-024251-TG-C-N

This rebuttal testimony addresses several statements contained in Edward Spencer's July 29, 2016 direct testimony on the Juniper Ridge Landfill (JRL) Expansion application filed by the Bureau of General Services (BGS) and NEWSME Landfill Operations, LLC (NEWSME). The statements I will address are associated with the Maine Solid Waste Management Hierarchy and conditions of the Public Benefit Determination (PBD). In addressing these statements I have identified where in the application information is presented, or provided additional supplemental information, to demonstrate that the Mr. Spencer's statements are incorrect or unfounded.

On page 2 of his direct testimony, Mr. Spencer states: "Only in the past several years has our Waste Hierarchy become a criteria governing how we handle wastes in Maine, and this expansion procedure is the first time DEP will fully implement the Hierarchy as the rule of the State of Maine."

In fact, the recently approved Maine Department of Environmental Protection (DEP) solid waste license for the Municipal Review Committee (MRC) and Fiberight (BGS/NEWSME Exhibit #48) for the construction and operation of a regional solid waste processing facility in Hampden, Maine, involved the first major application of compliance with the hierarchy as a licensing standard as implemented by the DEP. The proposed MRC facility is a processing facility that will primarily accept MSW, so the comparison of compliance with the hierarchy is not necessarily identical with that of the Juniper Ridge Landfill expansion. Processing facilities must, however, affirmatively demonstrate that their purpose and practices are consistent with the solid waste management hierarchy, including evidence of consistency with the standards of 06-096 CMR 409(2)(C), and evidence of the feasibility of recycling or processing all proposed waste streams into a fuel, raw material substitute or other product in conformance with the applicable provisions of 06-096 CMR 409 and 418. Specifically, the rules require:

> "An applicant for a new or expanded solid waste processing facility that generates residue requiring disposal must demonstrate that the proposed facility:
>
> (1) Will recycle or process into fuel for combustion all waste accepted at the facility to the maximum extent practicable, but in no case at a rate less than 50%. For purposes of this subsection, "recycle" includes, but is not limited to: reuse of waste as shaping, grading or alternative daily cover materials at landfills, aggregate material in construction, and boiler fuel substitutes, when such reuse is consistent with all applicable requirements of the Solid Waste Management Rules, 06-096 CMR 400 to 419; …"

06-096 CMR 409(2)(C).

The Department found this standard to be adequately addressed. (BGS/NEWSME Exhibit #48, Findings of Fact #20, pp 27- 29.) In addition to residual and bypass landfill disposal under normal operating conditions, the Department also approved "MSW Bridge Capacity" for all of the waste, defined as MSW, that is delivered between April 1, 2018, and the start of commercial operations (date undefined in the license) of the Fiberight facility to be landfilled at the Waste Management Disposal Services of Maine Crossroads Landfill in Norridgewock, Maine, in accordance with the Solid Waste Disposal Agreement between that facility and the MRC and Fiberight. (BGS/NEWSME Exhibit #48, Findings of Fact #15, p. 21.)

The Maine solid waste management hierarchy, 38 M.R.S. § 2101, establishes that it is the policy of the State to "plan for and implement an integrated approach to solid waste management" through an order of priority that places waste reduction, reuse, recycling, composting, and processing before land disposal as a "guiding principle in making decisions relating to solid waste management." In this first major instance of applying the hierarchy in a licensing process, the Department concluded that the MRC and Fiberight's proposed facility met the State's hierarchy standard, even though a significant amount of the waste from the Fiberight process will need to be disposed in a landfill. Compliance with the waste management hierarchy in the DEP Order approving the Fiberight project clearly established a critical, necessary, and essential role for landfilling in order for this project to function.

Mr. Spencer's discussion of "point of discard" (see his testimony on pages 2-3), is irrelevant to these proceedings for two reasons. First, the definitions he cites are from EPA regulations for Non-Hazardous Secondary Materials (NHSM) to determine whether NHSMs are solid wastes when used as fuels or ingredients in combustion units to determine which Clean Air Act emission standards apply, and has no applicability to this proceeding.

Second, the DEP solid waste rules do not require evidence on the point of origin, as Mr. Spencer advocates. Rather, the rules require submissions to include affirmative demonstrations that the purposes and practices of the solid waste facility (here the JRL Expansion) are consistent with the hierarchy. Those rules provide that "[s]uch evidence shall include, but is not limited to, a description of the reduction, reuse, recycling, composting and/or processing programs/efforts that the waste is or will be subject to, *and that are sufficiently within the control of the applicant to manage or facilitate*." 06-096 CMR 400(4)(N)(2)(a) (emphasis added).

JRL's customers, the sources of the construction and demolition debris (CDD) residuals, fines and bulky waste, that Mr. Spencer appears most concerned about, are primarily two Maine licensed CDD processing facilities: ReEnergy in Lewiston, and ARC in Eliot. Neither of these facilities is owned or controlled by NEWSME or BGS. Nevertheless, the recycling and source reduction requirement for the Juniper Ridge Landfill expansion pertains to the waste JRL accepts from those facilities. CDD processing facilities in Maine must demonstrate they are complying with State law by recycling or processing into fuel for combustion all waste accepted at the facility to the maximum extent practicable, but in no case at a rate of less than 50%. 38 M.R.S. § 1310-N (5-A)(B).

In their respective annual reports to DEP, ReEnergy and ARC have demonstrated that they have met their statutory recycling and source reduction requirements. (BGS/NEWSME Exhibits #49 and #50.) In 2015, ReEnergy reported a recycling rate of 78.7% and ARC reported a recycling rate of 84%.

Likewise, the waste management hierarchy, now a licensing standard, applies to the solid wastes proposed to be received by the facility under review, in this case the Juniper Ridge Landfill expansion. The question here is: could the post-processing CDD material that JRL receives from ARC and ReEnergy be instead reduced, reused, composted, or incinerated by BGS and NEWSME instead of recycled, in the case of CDD fines as alternate daily cover, or landfilled, in the case of residuals? The answer is no. Reducing would require downsizing or closing these two processing facilities, and is not within the control of the applicants. The waste material from these facilities has no additional reuse potential. Recycling has been demonstrated as described above in each facility's annual reports. CDD in general, and in particular post-processing material, is unacceptable waste at MSW incinerators in Maine. The residuals from these CDD processing facilities are not compostable. Landfilling is the only feasible solid waste management option for these materials. Therefore, the hierarchy has been met.

This licensing proceeding does not require the applicant for the expansion to demonstrate that other Maine licensed solid waste facilities (e.g., ReEnergy and ARC) are complying with the hierarchy regarding the unprocessed CDD they receive. That is an obligation those other facilities would need to demonstrate if and when they seek regulatory approval. To impose such an obligation on the JRL applicant would require that BGS and/or NEWSME could in some way control how either of these CDD processing facilities operate, or what solid wastes they accept. We do not, and therefore we have no ability or power to affect their compliance with the hierarchy.

Also on page 2 of his testimony, Mr. Spencer states that "During Casella's operation of JRL, they have failed to fully identify the True Source of all wastes funneled into JRL." This is inaccurate. In its monthly waste actvity reports that NEWSME has continually provided to BGS (previously to that State Planning Office), the DEP, the City of Old Town, and the Landfill Advisory Committee, the origin (customer and location) of every waste load delivery to JRL has been identified. As Mr. Labbe indicated in his pre-filed testimony, the monthly report data includes the following information: date of delivery, approval (manifest) number, waste description, quantity delivered in tons, transporter name, generator name, and waste origin (by Maine county). (BGS/NEWSME Exhibit #47.) Additionally, annual reports are completed documenting annual totals and major categories of wastes accepted and submitted to the DEP, BGS and City of Old Town.

Mr. Spencer further states on page 2 of his direct testimony: "However, now that our Waste Hierarchy is mandated as the law of the State, and therefore JRL, the rules require more information that identifies the True Source, or Point of Discard." Nothing in the DEP rules pertaining to the waste management hierarchy mentions "true source" or "point of discard" or "require more information" in this regard than BGS/NEWSME have provided in the application. All waste proposed to be accepted in the JRL expansion, is, as defined by statute, waste generated in Maine. 38 M.R.S. § 1310-N(11). The requirements for compliance with the hierarchy pertain to those wastes that are generated in Maine. The sources of those wastes that will be accepted for disposal in the expansion are located in Maine.

On page 4, second paragraph, of his testimony, Mr. Spencer comments on a recommendation, made by the Commissioner in Conclusion 6 of the 2012 PBD for the Expansion. This recommendation cites "the significant quantity of CDD imported into Maine under the terms of the OSA, and the associated large volumes of processing residues delivered to the Juniper Ridge Landfill."

The basis for this recommendation (that Casella and the State should amend the OSA), and for Condition 3 of the PBD (a numerical limit on OBW disposed in the Expansion) appear to have been the ownership of the CDD processing facility producing most of the CDD residues that were proposed to be disposed in the Expansion:

> "As shown in Attachment B, the most significant change in CDD generation results from a significant increase in the amount of oversized bulky waste ("OBW") and fines, primarily from KTI in Lewiston, disposed at Juniper Ridge Landfill. *KTI is a Casella subsidiary.* The majority of CDD accepted at KTI is imported from other states."

PBD, p. 11 (emphasis added).

The State could not lawfully impose a restriction on the source of CDD being accepted at the Lewiston facility because this was a separately licensed, commercially owned facility. However, the Commissioner perhaps felt that, at the time of the PBD decision, given the commonality of ownership of KTI and the operator of JRL (as NEWSME), a numerical limit on the amount of OBW that could be accepted for disposal in the JRL expansion might have the indirect effect of reducing out of state CDD being processed at KTI.

Casella no longer owns or operates the CDD processing facility in Lewiston. This was sold to ReEnergy in 2013, following the PBD approval. Neither Casella nor NEWSME has any control over the amount of CDD that is accepted and processed at the ReEnergy facility, how the facility is operated or how much OBW it generates. The change of ownership of the Lewiston CDD processing facility represents a material change in circumstances from 2012 regarding the Commissioner's recommendation and Condition 3 of the PBD.

JRL is the disposal facility that ReEnergy Lewiston has designated as the disposal site for its residues, including any OBW, as required by its DEP operating license. An arbitrary limit on OBW disposal at JRL will require ReEnergy to designate another landfill as back-up disposal should JRL reach its limit and have to turn ReEnergy away. This could increase ReEnergy's operating costs, which in turn could increase costs to its customers. This, in turn, could deter CDD recycling in Maine.

JRL is a state-owned disposal facility that was established to accept Maine-generated wastes. This intended purpose would be thwarted by a numerical limit on accepting OBW from Maine facilities such as ReEnergy. As identified in the August 1, 2016, letter from NEWSME to Kathy Tarbuck at DEP, historical sources of OBW disposed at JRL are not limited to the Lewiston CDD processing facility: the Penobscot Energy Recovery Company (PERC) has also delivered OBW to JRL. A numerical OBW limit for the JRL Expansion could limit the ability of PERC as well to utilize the JRL Expansion for this waste material.

On page 5 of his direct testimony, Mr. Spencer argues that Mr. Barden and Mr. Labbe rely improperly on the DEP Maine Materials Management Plan from 2014, which states that landfilling is the best way to handle OBW, because the rules on the solid waste hierarchy have changed since then. Mr. Spencer is only partially correct. While it is true that the waste management hierarchy did not become a *permitting standard* until adoption of 38 M.R.S. § 1310-N(1)(D) in 2014, and the subsequent DEP rulemaking in 06-096 CMR 400 § 4(N) in 2015, the waste management hierarchy has existed as a State *policy* since at least 1989 when the Legislature first adopted it. *See* 38 M.R.S. § 2101 (adopted as P.L. 1989, c. 585, § A, 7). Thus, DEP presumably prepared the Maine Materials Management Plan in 2014 in compliance with that policy. The implication of Mr. Spencer's argument – that things have materially changed since DEP stated that landfilling is the best way to handle OBW – is, therefore, incorrect, because the waste management hierarchy pre-dates that document by more than twenty-five years.

Also on page 5, Mr. Spencer asks for a "comprehensive portrait of Casella's network of landfills throughout the northeastern United States." Such landfills are not relevant to this proceeding. Moreover, aside from JRL, Casella's other landfills accept waste primarily from sources other than Maine. In general, standard transportation costs preclude waste material movement over large distances. JRL is limited to waste generated within the State of Maine. Other Casella landfills have no bearing on the amount of Maine CDD or CDD residuals that will be disposed in the JRL expansion.

Dated: 1 SEP 16

Toni M. King

STATE OF MAINE
Penobscot, ss.

Personally appeared before me the above-named Toni M. King and made oath that the foregoing is true and accurate to the best of her knowledge and belief.

Before me,

Dated: 9/1/16

Notary Public
Name: Maria J. Thibodeau
My Commission Expires: 6/6/22

BGS/NEWSME 48

STATE OF MAINE
DEPARTMENT OF ENVIRONMENTAL PROTECTION
17 STATE HOUSE STATION AUGUSTA, MAINE 04333-0017

DEPARTMENT ORDER

IN THE MATTER OF

MUNICIPAL REVIEW COMMITTEE, INC. AND	)	SOLID WASTE
FIBERIGHT, LLC	)	LICENSE
HAMPDEN, PENOBSCOT COUNTY, MAINE	)	
SOLID WASTE PROCESSING FACILITY	)	
#S-022458-WK-A-N	)	
(APPROVAL WITH CONDITIONS)	)	NEW LICENSE

Pursuant to the provisions of the *Maine Hazardous Waste, Septage and Solid Waste Management Act,* 38 M.R.S. §§ 1301 to 1319-Y; the *Rule Concerning the Processing of Applications and Other Administrative Matters,* 06-096 C.M.R. ch. 2 (last amended October 19, 2015); and the *Solid Waste Management Rules: General Provisions,* 06-096 C.M.R. ch. 400 (last amended April 6, 2015); *Water Quality Monitoring, Leachate Monitoring, and Waste Characterization,* 06-096 C.M.R. ch. 405 (last amended April 12, 2015) and *Processing Facilities,* 06-096 C.M.R. ch. 409 (last amended July 27, 2014), the Department of Environmental Protection ("Department") has considered the application of the MUNICIPAL REVIEW COMMITTEE, INC. and FIBERIGHT, LLC, with its supportive data, agency review comments, staff summary, and other related materials on file and FINDS THE FOLLOWING FACTS:

1. APPLICATION SUMMARY

A. Application: The Municipal Review Committee, Inc. ("MRC") and Fiberight, LLC, ("Fiberight") have jointly applied to construct and operate a regional solid waste processing facility in Hampden, Maine.

B. History:

(1) The MRC is a non-profit organization comprised of 187 municipalities and inter-municipal entities in central, eastern and northern Maine that currently send their municipal solid waste ("MSW") to a waste-to-energy plant located in Orrington, Maine.

(2) The MRC was formed in 1991 to work with the waste-to-energy plant partnership to improve facility operations and economic performance. The MRC is governed by 9 directors elected by the membership.

(3) The MRC Board of Directors has the authority to manage investments and authorize the disbursement of funds as deemed appropriate under the terms and conditions of their bylaws and agreement(s) with each charter municipality.

(4) Fiberight is a privately held company founded in 2007 with current demonstration facility operations in Lawrenceville, Virginia. The company focuses on transforming post-recycled MSW and other organic feedstocks into next generation renewable biofuels.

(5) Fiberight is recognized by Maine's Bureau of Corporations, Elections and Commissions as a Foreign Limited Liability Company and it filed a Statement of Foreign Qualifications to Conduct Activities (Charter #20150853FC) with a nature of the business described as the solid waste processing of trash into biofuels.

C. Summary of Proposal: The MRC and Fiberight have established a contractual agreement to construct and operate a regional solid waste processing facility in Hampden, Maine. The Application for a Solid Waste Processing Facility (hereinafter "Application") was prepared by CES, Inc. and is dated June 2015. The Application was subsequently revised with supplemental submittals with various dates. The proposed processing facility will accept and process MSW from numerous MRC member communities in central, eastern and northern Maine. The MRC and Fiberight also have an interest in accepting and processing MSW from in-state non-MRC communities that may decide to contract with the MRC and Fiberight. Pursuant to the provisions of 06-096 C.M.R. ch. 2, § 10, a pre-application meeting was held on March 19, 2015. On July 15, 2015, the Application was considered complete for processing.

2. PUBLIC PARTICIPATION

Written public comments were received by the Department including 5 requests for a public hearing pursuant to the provisions of 06-096 C.M.R. ch. 2, § 7(A). The written public comments and public hearing requests were made available to the public via the Department's website.

A. Written Public Comments: Written comments were received from local residents, several municipalities, the Maine Resource Recovery Association, and the Natural Resources Council of Maine.

B. Public Hearing Requests: The Department received 5 requests for a public hearing. The requests included concerns regarding several components of the Application including but not limited to vernal pools, wetlands, a nearby stream, traffic, property values, air emissions, and the waste hierarchy. The Department determined that there was insufficient credible conflicting technical information regarding relevant licensing criteria to necessitate a public hearing. Based on the Commissioner's discretion, a public meeting was held on November 19, 2015 in accordance with the provisions of 06-096 C.M.R. ch. 2, § 8. The purpose of the meeting was to provide an overview and opportunity to comment on the joint applications filed with the Department.

C. Draft License Decision: The Department released a draft Department License Decision (Draft License) on June 13, 2016. The Draft License was made available to the public via the Department's website. The MRC and Fiberight and interested persons were notified of the availability of the Draft License. The comment period on the Draft License closed on July 5, 2016. The Department received several comments regarding the Draft License. All of the comments were reviewed and given consideration in relation to the relevant review criteria in the Maine Hazardous Waste, Septage and Solid Waste Management Act and associated rule. The comments received included concerns regarding several components of the Application including but not limited to title, right or interest, financial ability, technical ability, process design and the solid waste management hierarchy. Included with the comments were additional requests for the Department to hold a public hearing.

(1) Title, Right or Interest: Commenters noted that the MRC does not have the authority to take on joint liability and to expend member funds. The Department notes that the Joinder Agreements executed between each charter municipality and the MRC delegates authority to the MRC to act on behalf of the municipality, consistent with the MRC bylaws. As part of the Joinder Agreement, amended and restated bylaws of the MRC are provided that outline MRC's authority in regards to the proposed processing facility. The Department notes that the MRC has provided an option to purchase the property associated with the proposed processing facility pursuant to the applicable rule. Additionally, the Department notes that the MRC's authority is governed by state law, the MRC bylaws and associated terms and conditions of their respective agreements. Based on this information, the Department finds that the MRC has submitted adequate evidence of title, right or interest.

(2) Financial Ability: Commenters noted that the Application does not demonstrate that the MRC and Fiberight have the financial ability to design, construct, operate, maintain and close the proposed processing facility. The Department notes that Fiberight has provided a letter of "Intent to Fund" in accordance with the applicable rule and that finalized financial documentation will be submitted once the necessary regulatory and local approvals are received. Submittal of the finalized financial documentation is a condition of the license. The Department reviewed and considered the concerns relating to financial ability and determined

that the condition to the Department's license that requires the MRC and Fiberight to demonstrate final financial capacity will provide the Department with adequate assurance that the MRC and Fiberight have the financial ability to design, construct, operate, maintain and close the proposed processing facility in a manner consistent with state environmental regulations.

(3) Technical Ability: Commenters noted that the MRC and Fiberight do not have the technical expertise to design, construct, operate, maintain and close the proposed processing facility. The Department notes that while Fiberight will be responsible for daily operations of the proposed processing facility and Fiberight has experience operating a demonstration scale processing facility, Covanta will be the operator for the proposed processing facility. Covanta has more than 30 years of experience converting MSW into clean renewable energy, recycling metals and other commodities, and helping communities meet their goals for environmental stewardship and sustainability. The Department reviewed and considered the concerns relating to technical ability and determined that the condition to the Department's license that requires the MRC and Fiberight to submit specific professional qualifications for personnel who will be responsible for operations, in addition to the technical ability information provided with the Application, provides the Department with adequate assurance that the MRC and Fiberight have the technical ability to design, construct, operate, maintain and close the proposed processing facility in a manner consistent with state environmental regulations.

(4) Process Design: Commenters noted that there was inconsistent information and terminology regarding the proposed process design. Based on the comments, the Department has revised the relevant sections of the license that pertain to the proposed process. The Department has clarified the proposed use of a reactor, instead of a digester, in the renewable fuel production process, removed the reference to the installation of an evaporator which is not being proposed as part of the Application, and clarified the proposed renewable energy production process design.

(5) Solid Waste Management Hierarchy: Commenters noted that the proposed processing facility project is not consistent with the State's solid waste management hierarchy which establishes that it is the policy of the State to actively promote and encourage waste reduction measures and the maximization of waste diversion efforts, and which sets forth an integrated approach to the management of solid waste. The Department notes that

the MRC and Fiberight will continue to support and encourage local waste reduction, reuse and recycling programs. The Department also notes that the Joinder Agreements entered into by the municipalities include a provision granting the municipality the sole option to establish, continue, expand or discontinue existing or future programs intended to encourage reduction, reuse, or recycling of MSW generated within its borders. Further, the proposed processing facility design will facilitate the removal of recyclables at the proposed processing facility that are not captured by programs implemented at the local level and will convert the remaining organics into renewable products. Based on the comments, the Department has added clarifying language in the relevant sections of the license relating to the solid waste management hierarchy including requiring Department reporting when MSW is brought for land disposal prior to the Commercial Operations Date being achieved and the submittal of a schedule outlining proposed measures that will be implemented in order to reach Commercial Operations.

(6) Public Hearing: Commenters noted that a public hearing is now warranted based on inconsistent and conflicting technical information within the Application. These requests are in addition to the public hearing requests received at the time of Application acceptance. The Department is unable to act on these new requests since they were not received within 20 days of the Application being accepted for processing as required by 06-096 C.M.R. ch. 2. The Department notes that while a series of supplemental submittals were provided after the Application was submitted and accepted for processing, a public hearing will not further the Department's understanding or technical knowledge of the proposed processing facility project. Additionally, the Department notes that the MRC and Fiberight have met the relevant review criteria in the Maine Hazardous Waste, Septage and Solid Waste Management Act and associated rule.

3. PROJECT DESCRIPTION AND SITE DESIGN

The proposed project site is located within an approximate 90-acre parcel located east of the Coldbrook Road in Hampden, Maine. The construction of a new 4,460-foot long road to provide access to the proposed project site from the Coldbrook Road is proposed on an additional 5-acre parcel of property. Department License #L-2647-NJ-A-N and #L-26497-TG-B-N, dated July, 2016, approved the construction of the proposed access road and utility corridor. Existing MRC member communities generate an average of 410 to 550 tons of MSW per day. The proposed processing facility is being designed to process 650 tons per day of MSW. Peak MSW delivery is estimated to be up to 950 tons per day to account for seasonal fluctuations.

The proposed processing facility will consist of a 144,000 square foot building that will provide for the receiving, storage and handling of MSW for processing and/or converting into recyclables, renewable fuels and residues for potential recycling and/or disposal off-site. The proposed processing building will contain a tipping floor designed to accommodate 2 days of inside storage capacity for raw MSW and 2 days of inside storage capacity for first sort material from which unsuitable waste such as textiles and large bulky items have been removed. Two-inch minus fines will also be removed at this stage for further processing. A second sort system will separate curbside-type recyclables from the first sort material that has been processed through a continuous pulper which has pulped and removed the majority of the organic material in the waste stream as a biomass pulp. The separated biomass pulp will be further processed to remove the entrained soluble organics and food waste leaving a clean biomass pulp. The clean biomass pulp will be prepared for enzymatic hydrolysis where the cellulosic fraction will be converted to sugars. The MRC and Fiberight state that the food wastes, other soluble organics and sugars produced from the clean biomass pulp will all initially be converted to bio-methane, via an anaerobic digester, which is proposed to be piped into an existing natural gas pipeline owned by Bangor Natural Gas located adjacent to the project site. In the future, the sugars may be sold directly as industrial sugars subject to prevailing market conditions.

Fiberight anticipates between 70 percent (%) and 80% by weight of all incoming MSW will be converted to renewable fuels or recycled, and the remaining 20% to 30% by weight will be process residues to be disposed off-site. In addition to residues and other unsuitable materials that will require off-site disposal, the MRC and Fiberight have planned for the disposal of MSW bypass waste expected to be generated during scheduled and unscheduled facility downtimes or for other unforeseen circumstances when the facility cannot accept and process MSW.

The Department finds that the MRC and Fiberight have adequately planned for site design; provided that, at least 30 days prior to commencing construction of the proposed access road and associated utility corridor and 60 days prior to commencing construction of the processing facility, the MRC and Fiberight submit a complete set of construction-ready plans and documents for each component of the proposed project to the Department for review and approval.

4. TITLE, RIGHT OR INTEREST

The MRC and Fiberight estimate that approximately 95 acres will be acquired, which includes a 90-acre parcel where the proposed processing facility will be constructed and a 5-acre parcel for the construction of a new 4,460-foot long access road. Pursuant to 06-096 C.M.R. ch. 2, § 11(D)(3), the MRC has provided an *Option to Purchase*, dated December 1, 2014, for the property necessary for the development of the proposed processing facility and access road from the properties current owners, H.O. Bouchard, Inc. and Hickory Development, LLC. The MRC Board of Directors has the authority to manage investments and authorize the disbursement of funds as deemed appropriate under the MRC's bylaws and associated terms and conditions of their agreement(s) with each charter municipality. As outlined in the *Development Agreement*, dated February 4, 2015, between the MRC and Fiberight, the MRC will purchase and own, and/or otherwise secure long-term control of, the properties necessary for the proposed processing facility. Fiberight will retain ownership of the processing facility and will lease the property owned by the MRC as outlined in the *Development Agreement*. The expiration date for the *Option to Purchase* is March 31, 2017.

The Department finds that the MRC and Fiberight have demonstrated adequate evidence of title, right or interest in the properties for the proposed project site; provided that, the MRC and Fiberight submit a copy of the deed(s) or executed long-term lease agreement(s) for the properties purchased and/or leased for the development of the proposed project within 30 days after the closure of sale and/or execution of the long-term lease agreement(s).

5. NOTICE OF INTENT

The MRC and Fiberight have provided documentation of the publication of a "Notice of Intent to File" and have documented notification of abutters and other interested parties as required in 06-096 C.M.R. ch. 2. The Notice of Intent to File was made during June 2015. The application was accepted as complete for processing on July 15, 2015.

The Department finds that the MRC and Fiberight have complied with all of the public notice requirements of 06-096 C.M.R. ch. 2.

6. FINANCIAL ABILITY

The MRC and Fiberight have made shared financial commitments to ensure necessary funding is available for the design, construction, operations, maintenance and closure of the proposed project. The *Development Agreement*, mentioned in Findings of Fact ("FOF") #4 above, outlines the specific financial obligations for each party.

A. MRC: In general, the MRC will be responsible for securing fee ownership or long-term control of the project site appropriate for the development of the proposed project. Additionally, the MRC shall lease or sublease the project site to Fiberight under a long-term agreement having terms and conditions that support the development, financing, construction and operation of the processing facility, with appropriate oversight by the MRC.

Current cost estimates for portions of the development project for which the MRC has conditionally committed funding to have been provided including land acquisition, road and stormwater facilities, water and sewer utilities, natural gas utilities, and electric and telecom utilities. The total project cost estimate which the MRC has committed to funding is $4,230,000. The MRC will self-finance its share of the funding for the proposed project. The source of funds will be via a *Tip Fee Stabilization Fund* ("Fund"), which maintained a balance as of March 31, 2015 of $22,220,628. The MRC submitted a copy of a bank statement showing the Fund balance and a copy of its latest available audited financial statements. The MRC has committed to set aside up to $5,000,000 from the Fund to finance the land acquisition and infrastructure activities. No bonding or borrowing capacity is needed for the MRC to meet its financial commitment to the proposed project.

B. Fiberight: Current cost estimates for portions of the development project for which Fiberight will be responsible for include site development, foundations, concrete and building construction, machinery and equipment, steel, mechanical and electrical installation, and engineering, permits and project management. Total estimated capital costs for which Fiberight is responsible for is $66,976,786. Fiberight will also be responsible for the following estimated expenditures: annual operational costs, annual maintenance costs, and facility closure costs for a total cost of $12,700,000.

Pursuant to 06-096 C.M.R. ch. 400, § 4(B)(2)(b)(i)(b), Fiberight has provided a letter of "Intent to Fund", dated December 18, 2015, from Covanta Energy, LLC ("Covanta") stating that Covanta is engaged with Fiberight to support the development, financing, construction and operation of the proposed processing facility. Covanta conducted a review of financial projections relating to the project and executed a term sheet for a long-term strategic partnership with Fiberight. Covanta has reviewed the estimated budget for the proposed project, totaling approximately $67 million, and confirmed their interest in supporting Fiberight with project finance in the form of an equity investment in the proposed processing facility.

Covanta's letter is not intended to be a binding commitment to provide financing. A binding financial commitment is subject to successful completion of due diligence activities; including, but not limited to, the proposed project receiving relevant Federal, State and local permits, and Fiberight entering into acceptable waste supply agreements with the MRC and its charter municipalities. Covanta's role in the proposed processing facility will be as an investor and operator. Covanta has supplied adequate evidence of its ability to fund the construction and operation of the proposed processing facility; however, the ultimate level of investment is still under consideration by Covanta. The intent is for Fiberight and Covanta to be joint investors in the proposed project.

C. Other: Letters of "Intent to Fund" were also provided by DTE Energy (dated June 11, 2015) and Argonaut Private Equity (dated June 17, 2015). In the event that either DTE Energy or Argonaut Private Equity is utilized for funding, their involvement with the proposed project will be in the form of project financing only, acting as a financial institution.

Once permits are issued, and prior to project construction, final evidence of the specified and sufficient amount of funds for each party will be provided to the Department in accordance with 06-096 C.M.R. ch. 400, § 4(B)(2)(b)(i)(a).

The Department finds that the MRC and Fiberight have submitted adequate evidence of financial capacity to design, construct, operate, maintain and close the proposed processing facility in a manner consistent with state environmental regulations; provided that, the MRC and Fiberight submit, within 30 days of receipt and prior to beginning construction of the proposed processing facility, exclusive of the access road that is funded solely by the MRC, to the Department for review and approval the finalized financial documents for the construction and operation of the proposed processing facility.

7. TECHNICAL ABILITY

The MRC and Fiberight have retained several consultants to support the design, construction, operation, maintenance and closure of the proposed processing facility.

A. MRC: The MRC manages the affairs and concerns of their current 187 municipal members. The member-led MRC has successfully managed the current 30-year contract with the Penobscot Energy Recovery Corporation ("PERC") waste-to-energy facility, located in Orrington, Maine, since 1991. The MRC, on behalf of the Equity Charter Municipalities, purchased and manages a 23% ownership interest in the PERC facility. As part of this function, the MRC conducts the following: monitors the PERC facility's performance, reviews and votes on the facility's annual operating budget and decisions to invest in capital and major maintenance projects, and oversees actions taken and investments made to the PERC facility to ensure that potential environmental impacts are avoided and mitigated appropriately.

B. Fiberight: Fiberight will be responsible for daily operations of the proposed processing facility. Fiberight has demonstrated the technical ability to operate a similar, smaller scale MSW processing demonstration facility located in

Lawrenceville, Virginia. The Fiberight team associated with the proposed processing facility is the same team responsible for the design and operation of Fiberight's demonstration facility in Virginia. Fiberight has submitted the résumés of those individuals responsible for the demonstration facility's design, construction and operation.

C. CES, Inc: CES, Inc. (CES) is an environmental consulting firm, with its headquarters located in Brewer, Maine, with experience in preparing applications for submittal to the Department. CES provided personnel to assist with permit application preparation, site investigation and site design for the proposed project. CES has also been retained by the MRC and Fiberight to provide on-going environmental compliance assistance when needed.

D. S.W. Cole Engineering, Inc: S.W. Cole Engineering, Inc. ("SW Cole") is an engineering firm with offices in Maine, New Hampshire and Vermont that provides construction materials testing and geotechnical services. SW Cole conducted sub-surface explorations to address soil suitability of the proposed project site and provided geotechnical engineering services pertaining to the construction of the foundation for the proposed processing facility building and associated structures.

E. Amec Foster Wheeler: Amec Foster Wheeler ("AMECFW") is a British multinational consulting, engineering and product management company with its global headquarters in London, England and branch offices worldwide and in the United States, including Portland, Maine. AMECFW has been retained to provide construction management services including contract scoping and preparation of contract packages, construction scheduling, project cost control, risk identification and management, quality assurance, contractor and construction site monitoring and on-site safety monitoring.

F. CommonWealth Resource Management Corporation: CommonWealth Resource Management Corporation (CRMC) is a management and environmental consulting firm focusing on issues and opportunities related to resource conservation, recovery and utilization. CRMC has been retained for general assistance relating to the design, construction, operation and maintenance of the proposed processing facility.

G. University of Maine: The University of Maine (UMaine) is a public research university with a focus on undergraduate and graduate research throughout Maine and around the world. UMaine Chemical Engineering professors have been retained to perform a peer review of the technological processes associated with the proposed processing facility.

H. Covanta: Covanta has their corporate headquarters in Morristown, New Jersey and places of business in West Enfield and Jonesboro, Maine. Covanta has more than 30 years of experience converting MSW into clean renewable energy, recycling metals and other commodities, and helping communities meet their goals for environmental stewardship and sustainability. Covanta will support the development, financing, construction, operation, and maintenance of the proposed processing facility. Covanta's role in the proposed processing facility will be investor and operator.

The Department finds that the MRC and Fiberight and their retained consultants have provided adequate evidence of technical ability to design, construct, operate, maintain and close the proposed processing facility in a manner consistent with state environmental regulations; provided that, the MRC and Fiberight submit to the Department for review and approval specific professional qualifications for personnel who will be responsible for operations at least 30 days prior to commencing pre-commissioning operations of the proposed processing facility.

8. DISCLOSURE OF CRIMINAL OR CIVIL RECORD

The MRC, Fiberight and Covanta have filed complete civil and criminal disclosure statements in accordance with 06-096 C.M.R. ch. 400, § 12(A).

A. MRC: The MRC is a non-profit corporation formed in 1991 pursuant to State of Maine law whose managerial and executive authority rests with the MRC officers and directors. No officer or director holds any equity or debt in the business entity. The MRC will not have managerial or executive authority over the proposed processing facility. The MRC's officers and directors do not hold more than a 5% equity interest in any company that collects, transports, treats, stores, or disposes of solid or hazardous wastes and do not have any criminal convictions (except for one director who had a misdemeanor criminal conviction in 1991) or civil violations of environmental laws or rules administered by the State, other states, the United States, or another country in the last 5 years. Additionally, the MRC officers and directors have not entered into any administrative agreements or consent decrees or had administrative orders directed at them for violations of environmental laws administered by the Department, the State, other states, the United States, or another country in the last 5 years.

B. Fiberight: Fiberight is a Delaware limited liability company with a main office in Baltimore, Maryland. Managerial and executive authority rests with the Fiberight officers and directors. No officer or director holds any equity or debt in the business entity. Fiberight's officers and directors do not hold more than a 5% equity interest in any company that collects, transports, treats, stores, or disposes of solid or hazardous wastes and do not have any criminal convictions or civil violations of environmental laws or rules administered by the State, other states, the United States, or another country in the last 5 years.

In 2014, Fiberight's Chief Executive Officer entered into a Complaint and Consent Agreement/Final Order (Agreement) with the United States Environmental Protection Agency for alleged violations to Sections 301, 311 and 402 of the *Clean Water Act*, 33 U.S. Code §§ 1311, 1321 and 1342, and regulations promulgated thereunder. Under the terms of the Agreement, Fiberight paid a monetary penalty, updated their facility Storm Water Pollution Prevention Plan (SWPPP), conducted employee training regarding the SWPPP and utilized qualified personnel to conduct inspections, developed and implemented a Spill Prevention Control & Countermeasure (SPCC) Plan, conducted employee training regarding the SPCC Plan and disconnected a pipe that had once been the source of an uncontrolled discharge. No additional Fiberight officers and directors have entered into any administrative agreements or consent decrees or had administrative orders directed at them for violations of environmental laws administered by the Department, the State, other states, the United States, or another country in the last 5 years.

C. Covanta: The MRC and Fiberight have submitted the disclosure information for Covanta's senior officers. Covanta's senior officers do not hold more than a 5% equity interest in any company that collects, transports, treats, stores, or disposes of solid or hazardous wastes and do not have any criminal convictions or civil violations of environmental laws or rules administered by the State, other states, the United States, or another country in the last 5 years. Additionally, senior officers have not entered into any administrative agreements or consent decrees or had administrative orders directed at them for violations of environmental laws administered by the Department, the State, other states, the United States, or another country in the last 5 years.

The Department finds that the MRC, Fiberight and Covanta have filed complete disclosure statements in accordance with 06-096 C.M.R. ch. 400, § 12(A). Based on the disclosure statements submitted and the evaluation criteria contained in 06-096 C.M.R. ch. 400, § 12(B), the Department finds no basis for denying the license.

9. TRAFFIC MOVEMENT

Traffic for the proposed processing facility will enter and exit at a single point of access located at the northeast corner of the project site. The processing facility entrance will be located at the end of a proposed 4,460-foot long access road which will enter onto the Coldbrook Road directly across from an existing truck facility access road. The proposed access road will be paved, approximately 30 feet in width (consisting of 2, 12-foot travel lanes with 3-foot shoulders), and end at a cul-de-sac at the proposed processing facility entrance. An Entrance Permit Application for the access road entrance onto the Coldbrook Road was submitted to, and a permit issued by, the Maine Department of Transportation ("MDOT") (Permit # 15947 – Entrance ID: 1, dated May 22, 2015). Sight distances for the proposed access road exceed the requirements of the MDOT Entrance Permit.

The main traffic associated with the proposed processing facility will be from incoming MSW deliveries and employees. Additional traffic components will include general deliveries, outgoing process residues and recyclables generated by the proposed processing facility, material deliveries related to the proposed processing facility and outgoing product deliveries from the proposed processing facility. Incoming MSW deliveries will enter and exit the proposed processing facility in trucks ranging from packer trucks to trailer trucks. The highest expected total of MSW deliveries to the proposed processing facility on any given day is 89, comprised of 53 packer trucks, 26 roll-off trucks and 10 trailers. A delivery will equate to 2 vehicle trips (1 entering and 1 exiting the facility). Employee, visitor and delivery traffic is expected to generate 168 total vehicle trips per day. Traffic from the shipment of outgoing process residues and recyclables and incoming material deliveries will vary.

A MDOT Traffic Movement Permit is not required because the proposed project's estimated overall traffic volume is less than 100 passenger car equivalents during the peak hour. The MRC and Fiberight estimate a peak traffic volume of 356 vehicle trips per day, spread throughout the entire day. The interior processing facility road network consists of employee and visitor parking lots and site roads varying from 2 to 3 lanes and various lengths. All interior roads will be paved. The speed limit of the interior roads will be 15 miles per hour. The MRC and Fiberight have provided information regarding haul routes, road characteristics and information regarding traffic accidents in the vicinity of the proposed project site in the last 3 years. No high crash locations were identified.

The Department finds that the MRC and Fiberight have made adequate provisions for safe and uncongested traffic movement of all types into, out of, and within the proposed project area.

10. FITTING HARMONIOUSLY INTO THE NATURAL ENVIRONMENT

A. General: The MRC and Fiberight have designed the proposed processing facility to fit harmoniously into the natural environment. CES has provided information related to any protected significant wildlife habitat, unusual natural areas, rare, threatened or endangered plant species, and protected natural resources. CES, on behalf of the MRC and Fiberight contacted the Maine Department of Inland

Fisheries and Wildlife ("MDIFW") and the Maine Natural Areas Program to identify any of the above features.

B. Setbacks and Buffers: The MRC and Fiberight have stated that the areas to the north, east and south of the proposed processing facility will be maintained in their natural wooded condition. The proposed building site will be 4 to 5 feet lower than the surrounding grade to the west. The waste handling area at the proposed processing facility meets all the setbacks required by the Rules.

C. Wildlife and Fisheries: In March 2015, CES sent a letter to MDIFW requesting information for known locations of Endangered, Threatened, and Special Concern Species, designated Essential and Significant Wildlife Habitats, and fisheries habitat concerns within the vicinity of the proposed project site. The MDIFW responded to CES in letters dated March 16, 2015 and March 18, 2015.

(1) Bats: With regard to information for known locations of Endangered, Threatened, and Special Concern Species, MDIFW stated that 7 out of 8 species of bats in Maine are currently listed as Species of Special Concern; however, 3 species of bats are currently being considered through the legislative process for protection under Maine's list of Threatened and Endangered Species. At the time of Application submittal, the Northern Long-eared Bat was listed as Endangered under the Federal Endangered Species Act (listed April 2, 2015). Subsequent to the Application submittal, the Little Brown Bat and Northern Long-eared Bat were listed as Endangered in Maine and the Eastern Small-footed Bat was listed as Threatened in Maine.

In consultation with the U.S. Fish and Wildlife Service ("USFWS"), an acoustical bat survey was developed in order to assess bat activity and to determine the presence, if any, of Northern Long-eared Bats within the proposed processing facility site. The acoustical bat survey was conducted during the summer of 2015. The acoustical bat survey did not identify any federally protected bat species within the proposed processing facility site. The MRC and Fiberight have agreed to follow conservation guidelines for tree cutting, as outlined by USFWS in the interim Federal 4(d) Rule, effective May 4, 2015, to minimize potential impacts to listed bat species. An acoustical bat survey was not completed on the utility corridor; however, an acoustical survey of the utility corridor is planned for July 2016. The submittal to the Department of a forest management plan that contains provisions which will maintain the wildlife habitat functions and values is a condition of Department License #L-26497-NJ-A-N and #L-26497-TG-B-N. Construction activities will follow recommended management guidelines provided by the USFWS to minimize potential impacts to bat species.

(2) Vernal Pools: A comprehensive inventory of vernal pools was completed during spring 2015 and identified 44 vernal pools within the proposed processing facility site. Nine pools met the Department's definition of significant vernal pool. Construction of the proposed access road will occur within 250 feet of one significant vernal pool. This significant vernal pool is designated as Pool #2632 according to the Department's Geographic Information System and VP 1-10 within the Application. Alteration of this vernal pool habitat was authorized under the Natural Resources Protection Act Permit by Rule Notification Form (PBR #59983) pursuant to *Natural Resources Protection Act Permit by Rule* standards, 06-096 C.M.R. ch. 305 (last amended June 8, 2012).

(3) Fisheries: With regards to fisheries habitat, the MDIFW made the following recommendations: a 100-foot undisturbed vegetated buffer be maintained along any mapped or unmapped streams; stream crossings should be avoided, but if necessary, the crossing should be designed to provide adequate fish passage; and Construction Best Management Practices ("BMPs") should be closely followed and that any necessary instream work or work within 100 feet of streams occur between July 15 and October 1. Consideration of MDIFW's recommendations was included in Department License #L-26497-NJ-A-N and #L-26497-TG-B-N.

(4) Deer Wintering Area: MDIFW stated that there is a large mapped Deer Wintering Area ("DWA") within the project search area. MDIFW staff walked the proposed processing facility site with CES staff and commented that a portion of the DWA has been selectively harvested within the last decade and a large amount of softwood cover that characterizes a DWA was removed. MDIFW staff comments that while the specific location to be developed lacks suitable winter shelter habitat, areas located to the east of the proposed processing facility building site do provide appropriate winter shelter for deer. MDIFW recommends that the remaining undeveloped portions of the proposed processing facility site be protected and managed for winter shelter. MDIFW staff comments that a timber management plan that details the management actions necessary to maintain deer winter shelter areas should be drafted and become part of this longer term protection effort.

D. Unusual Natural Areas: The Natural Areas Program within the MDIFW did not find evidence of any rare or unique botanical features on, or adjacent to, the proposed project site. Rare and unique botanical features include the habitat of rare, threatened, or endangered plant species and unique or exemplary natural communities.

E. Protected Natural Resources: Natural resource work has been completed at the proposed project site. The MRC and Fiberight are proposing to impact a total of 105,000 square feet of forested wetland to construct the proposed processing facility, access road, and the utility corridor. The development of the proposed access road and processing facility building will require alterations to freshwater wetlands, significant wildlife habitat and other protected natural resources. Impacts to protected natural resources will be addressed by obtaining a permit pursuant to *Natural Resources Protection Act*, 38 M.R.S. § 480-A et *seq.*, as required. The MRC and Fiberight have submitted Natural Resources Protection Act permit applications to both the Department and U.S. Army Corps of Engineers.

In July 2016, the Department issued Department License #L-26497-NJ-A-N and #L-26497-TG-B-N approving the construction of an access road, utility corridor and alterations to freshwater wetlands, significant wildlife habitat and other protected natural resources on the proposed project site.

The Department finds that the proposed project will fit harmoniously into the surrounding environment; provided that, the MRC and Fiberight: (1) submit the results of the acoustical bat survey to be completed within the utility corridor; and (2) develop a timber management plan that details the management actions necessary to maintain deer winter shelter areas. The Department further finds that at least 14 days prior to commencing construction of the proposed processing facility, the MRC and Fiberight must submit the acoustical bat survey to be completed within the utility corridor and a timber management plan to maintain deer winter shelter areas.

11. AIR QUALITY

The proposed project site is buffered by existing forested areas and is approximately 3,400 feet away from the nearest existing residential building. The proposed processing facility is designed with multiple systems and procedures to minimize the generation of, and provide control of, objectionable and nuisance odors at any occupied building. All unloading of MSW will occur inside the proposed processing facility building. In order to minimize the number of waste delivery trucks in the parking lot at one time, the tipping floor is designed to accommodate 1 transfer trailer and 3 packer trucks simultaneously. The primary operational control for nuisance odors is minimizing the quantity, and the duration, of time that MSW sits on the tipping floor. The tipping floor is designed with storage capacity for 2 days of MSW receipts and 2 days of primary processed material. The MRC and Fiberight will utilize the principle of "First-in-First-Out" operation to the maximum extent possible to minimize the residence time of waste on the tipping floor. The tipping floor and processing portion of the building will be maintained under constant negative pressure by using a multiple hood/intake register air handling system. The air handling system will draw air from inside the building and treat it in either of 2 scrubber systems. One of the scrubbers will be operated at all times when MSW is present on the tipping floor. Both scrubbers will be operated when the high-speed fabric overhead doors used for truck entry or exit are open.

A Start-Up, Shutdown and Malfunction Plan has been developed that includes provisions for odor control during times when processing operations must be limited or suspended to perform equipment maintenance. The MRC and Fiberight have also established an Odor Complaint Response Plan that outlines procedures for odor complaint reporting, should they occur, and subsequent response actions including the use of an odor neutralization agent. As part of the operations of the proposed processing facility, regular odor inspections will be performed. Inspections will include, at a minimum, visual observation of the operations for obvious signs of damage or abnormal conditions within the proposed processing building that will affect collection efficiency of the odor control system and a visual inspection and odor survey around the exterior of the proposed processing facility.

The MRC and Fiberight have stated that during the first month of, and for a total of 6 months during, the first year of operation, a daily inspection and odor survey will be conducted around the proposed processing facility. The daily inspection period will include the summer months when waste odors are expected to be strongest. If operations commence in the winter months and no odor issues are identified during the first month, inspections will be reduced to weekly until the onset of warmer weather. If after 6 months, including summer months, no odor issues are identified then inspections will be reduced to weekly. Inspection results will be submitted to the Department weekly unless an odor incident is noted in which case the Department will be notified within the day. A summary of the odor survey reports will be submitted to the Department with the facility's annual report.

The MRC and Fiberight have submitted an application to the Department for a Minor Source Air License to address potential fugitive emissions from the proposed 2 biomass boilers, other fuel burning equipment and process equipment. The other fuel burning equipment includes a thermal oxidizer and flare. The details of this license can be found in Department License #A-1111-71-A-N, dated July, 2016.

Fugitive dust is not expected to be an issue. All travel ways and parking areas will be paved and no bulk material handling operations will occur outside the proposed processing building. Should fugitive dust emissions occur beyond the property boundary, the processing facility operator will assess the source of the dust and clean the travel ways and, if necessary, spray water to control dust.

The MRC and Fiberight propose to use 2 cooling towers to promote evaporative cooling of waste heat. The MRC and Fiberight have proposed the installation of drift eliminators to minimize any emissions of particulate that may occur. This is not expected to be a sufficient quantity to cause localized fog banks or icing beyond the property boundaries and should not unreasonably alter climate in the area of the processing facility.

The Department finds that there will be no unreasonable adverse effects on air quality and/or climate due to the proposed project.

12. SOIL SUITABILITY AND EROSION CONTROL

A subsurface investigation was completed by SW Cole to evaluate whether soil bearing capacity is sufficient to support the proposed processing facility and associated outdoor storage components. SW Cole concluded that based on the subsurface findings, the construction of the processing building appears feasible from a geotechnical standpoint. SW Cole provided geotechnical recommendations pertaining to the building's footings and on-grade floor slab and perimeter footings and the need for underdrains near footing grade and adjacent to paved areas. The recommendations have been incorporated into the building design. SW Cole also recommended that a contingency be made for the possible removal of bedrock via drilling or blasting.

The MRC and Fiberight have submitted an Erosion and Sedimentation Control Plan including an inspection and maintenance plan. Any proposed work will be carried out in conformance with the approved erosion and sedimentation control plan, the construction contract documents, and the Maine Erosion and Sediment Control Field Guide for Contractors, March 2015 or its equivalent.

The Department finds that the proposed processing facility will be constructed on soils suitable for the proposed use and will not cause unreasonable sedimentation or erosion of soil. The Department also finds that the MRC and Fiberight have adequately addressed erosion and sediment control for the proposed project, and have demonstrated that the proposed project will be carried out in conformance with the approved erosion and sediment control plan, the construction contract documents, and the Maine Erosion and Sediment Control Field Guide for Contractors, March 2015 or its equivalent.

13. SURFACE WATER QUALITY AND FLOODING

The proposed project site is not located within a 100-year flood plain and is not located within a direct watershed of a waterbody most at risk from new development. A 25-year, 24-hour storm event was modeled to determine the necessary detention and outlet sizing requirements for the proposed project site. The proposed building site will be located on an undeveloped and mainly wooded parcel of land approximately 90 acres in size in the Town of Hampden. Shaw Brook is classified as an Urban Impaired Stream and is located approximately 3,000 feet to the west of the parcel. Runoff from the site generally drains to a large forested wetland area to the south of the parcel before eventually draining to the Penobscot River. Runoff does not drain to Shaw Brook.

The proposed project will be built over a portion of previously undeveloped land and will add approximately 9.7 acres of developed area to the site. The project area will be treated with a combination of 3 vegetated under-drained soil filters and a roofline drip edge filter. All of these treatment measures discharge toward the south and west ends of the project site before re-joining the pre-development flow paths. The results of the post development analysis for the project site indicate that there is a reduction in runoff from the summation points, and that all of the stormwater treatment measures are sized adequately to handle stormwater runoff from 2, 10 and 25-year storm events. There are no anticipated adverse impacts to the downgradient areas, and as a result the development will have no unreasonable effect on run-on, run-off, and/or infiltration relationships on-site or on adjacent properties.

The Department finds that the proposed processing facility will not have an unreasonable adverse effect on surface water quality and will not unreasonably cause or increase flooding on the proposed facility site or on adjacent properties nor create an unreasonable flood hazard to any structure.

14. EXISTING USES AND SCENIC CHARACTER

The proposed building site includes an approximate 90-acre wooded parcel of land established as an industrial zone by the Town of Hampden. The proposed processing facility will be located approximately 0.25 miles from I-95 to the north, 0.8 miles from the Coldbrook Road to the west, 0.7 miles from the Ammo Industrial Park to the east and 1 mile from Route 202 to the south. The project site will be 4 to 5 feet lower than the surrounding grade to the west of the facility. The remainder of the project site is surrounded by a natural wooded buffer to the north, east and south. This buffer will be retained and will provide a visual screen to the north, east and south. There are no airport runways located within 10,000 feet of the existing site, no historic properties, and the existing site is located greater than 2,000 feet from the nearest established public viewing area. A portion of a neighboring property from the southwest to southeast is currently zoned as rural by the Town of Hampden. There are 2 residential subdivisions located approximately 3,400 feet to the south of, but not abutting, the proposed site.

The noise generated from the routine operation of the proposed processing facility must be less than or equal to 70 A-weighted decibel (dBA) for daytime and 60 dBA for nighttime hours at the facility property boundary. There are no protected locations within or in the vicinity of the project site's property boundary. As it relates to this Application, the applicable noises in the thresholds are limited to routine operations of the proposed processing facility. As a result, all applicable noise generating equipment will be located inside the proposed processing building and at no time will processing activities take place outside.

The Department finds that the proposed project will not have an unreasonable adverse effect on existing uses or scenic character. The Department also finds that the proposed project will not result in increased noise levels beyond the proposed project site's property boundary.

15. ADEQUATE PROVISIONS FOR UTILITIES

A. Water: The proposed processing facility will be served by the Town of Hampden Water District ("Hampden WD"), which is a municipal water supply and supplies potable water to the surrounding community. During steady state operation, the proposed processing facility will require an average water demand of 360,000 gallons per day ("gpd") with a peak flowrate of 300 gallons per minute ("gpm"). During maintenance periods, which could occur 3 to 4 times per year, the processing facility will require a maximum water demand of 132,000 gpd with a peak flowrate of 275 gpm, to fill various components in the processing system. The initial fill of the processing system will require approximately 3,500,000 gallons of water, completed over a 30-day period. The Hampden WD provided a letter, dated May 13, 2015, which states that it has the capacity and capability to meet the proposed flow requirements.

B. Wastewater: The MRC and Fiberight estimate that the processing facility will discharge an average daily flow of 150,000 gallons of domestic and process wastewater into the Town of Hampden's (Hampden) municipal sanitary sewer collection system, which is sent for treatment to the City of Bangor's Wastewater Treatment Plant ("Bangor WWTP"). The Bangor WWTP provided an updated letter, dated February 17, 2016, related to the estimated 150,000 gpd of wastewater to be generated by the proposed processing facility. Bangor WWTP states that it has capacity, at this time, to accept this additional flow during non-combined sewer overflow conditions. Further, the Bangor WWTP states that "alternative arrangements such as on-site storage or trucking to alternative sites" needs to be made during combined sewer overflow conditions.

In a March 30, 2016 Memo, CES assumed the need to provide on-site storage of 300,000 gallons or two times the estimated average daily flow. The MRC and Fiberight have proposed the installation of a 150,000 gallon aboveground tank and 100,000 gallon belowground tank and the utilization of 50,000 gallon buffer storage in an already designed process water storage tank. CES notes that the tank construction materials are still being evaluated and will be determined during final design.

Bangor WWTP also requires the user to provide the treatment plant with an Industrial User Permit Application and a Pretreatment Survey and Disclosure Form prior to discharging any effluent to their treatment system. Should it be determined that, for any reason whatsoever, adverse effects are noted or anticipated at the Bangor WWTP, the user shall be required to pre-treat wastewater discharge to acceptable levels. If the Pre-Treatment Survey shows that the proposed processing facility requires a pre-treatment system for its wastewater, the Bangor WWTP must approve the pre-treatment system prior to installation.

C. Solid Waste: The MRC has entered into a Solid Waste Disposal Agreement, dated August 15, 2015, with the Waste Management Disposal Services of Maine Crossroads Landfill in Norridgewock, Maine, to accept "MSW Bridge Capacity" waste (defined as MSW, brought to the facility between April 1, 2018 and the start of commercial operations, that cannot be fully processed), solid waste process residue, and MSW bypass waste for disposal. The MRC and Fiberight estimate a range between 30,000 to 40,000 tons per year of process residue waste and biomass boiler ash will require disposal. In addition, for planning purposes the MRC and Fiberight have made provisions for the disposal of an estimated 37,500 to 50,000 tons per year of MSW bypass waste to address any bypass events that may be necessary. The Master Waste Supply Agreement (MWSA), effective date January 1, 2016, between the MRC and Fiberight requires Fiberight to avoid or minimize bypass events, and only allows bypass events due to Force Majeure, limits on capacity resulting from an outage, a full tip floor, the need to avoid nuisance impacts, permit limits, or other factors beyond its reasonable control. The MWSA specifies procedures for the handling of MSW Bridge Capacity waste. Specifically, the MWSA requires Fiberight to use commercially reasonable efforts to (1) advance the occurrence of the Commercial Operation Date in order to be able to accept and process acceptable waste as soon as possible; (2) allow the facility to be used to accept and process acceptable waste to the extent practical, with the specific sources of acceptable waste being accepted to be determined in consultation with the MRC; and (3) allow the facility to be used to receive acceptable waste, and transfer amounts that are accepted but cannot be processed to the back-up facility, with the specific sources of acceptable waste being accepted to be determined in consultation with the MRC. The Department notes that the MRC and Fiberight need to minimize the amount of time, if any is needed, that MSW Bridge Capacity diversion is utilized, and that monthly reporting to the Department of MSW Bridge Capacity tonnage utilized and an updated schedule outlining the measures needed to reach Commercial Operation is necessary until such time as Commercial Operation is achieved.

The Department finds that the MRC and Fiberight have provided for adequate utilities and will have no unreasonable adverse effect on existing or proposed utilities in the municipality or area served by utilities; provided that: (1) the MRC and Fiberight submit copies of the Bangor WWTP Industrial User Permit and letter approving the operation of a wastewater pre-treatment system, if necessary, to the Department within 30 days of their receipt; (2) the MRC and Fiberight submit, for review and approval, the final design for the on-site wastewater storage tanks at least 60 days prior to construction of the proposed processing facility; and (3) the MRC and Fiberight submit monthly reports to the Department listing the tonnage of MSW Bridge Capacity utilized, if any is needed, and an updated schedule outlining the measures needed to reach Commercial Operation until such time as Commercial Operation is achieved.

16. GROUNDWATER QUALITY

The proposed project site does not overlie a significant sand and gravel aquifer. The closest mapped aquifer is approximately 4,000 feet to the northwest of the proposed project site. Unprocessed and processed MSW will be stored inside the proposed processing building. Residue materials, bypass waste and biomass boiler ash will be stored in trailers and transported off-site to a licensed, secure landfill for disposal. Recyclable materials will be stored on-site in either 100 cubic yard transport trailers or 40 cubic yard dump trailers. No unprocessed or processed materials will be stored outside on the ground.

The Department finds that the proposed processing facility will not pose an unreasonable threat to the quality of a significant sand and gravel aquifer and will not result in unreasonable adverse effects on groundwater quality.

17. PROCESS DESIGN

A. <u>General:</u> The proposed processing facility consists of 4 different processing stages which will process the MSW received into several different categories.

The 4 different processing stages are: materials recovery, renewable fuel production, renewable energy production, and industrial co-products. A series of process benchmarks has been established that will be used to evaluate the proposed process during various stages of project implementation as described below.

B. Materials Recovery Facility (MRF): The first stage in the process (primary MRF) is to remove large bulky items prior to the MSW being loaded into the primary trommel. Unwanted large bulky items will be removed on the tipping floor and on a pre-sort line and loaded on a trailer and transferred for disposal at a licensed landfill facility. The MSW is then fed to the primary trommel which opens and empties the bags of trash and size separates the material into over 20 inch and 20 inch and under. The 20 inch and under material is then further size separated by a fines screen to 2 inches or less in size which fraction continues through to the fines processing area for further processing. The over 2 inch to 20 inch material is stockpiled and subsequently conveyed to a drum pulper that breaks the organic material down to form a biomass, which facilitates separation of the recyclable materials from organic wastes, and prepares the biomass for further cleaning.

Materials exiting the drum pulper pass across a screen to separate recyclables, such as metals and plastics from the biomass pulp. These recyclable materials are then conveyed to the MRF to be further processed. The remaining biomass pulp is conveyed to a two-stage washing system to remove fine contaminants (mostly plastics) and soluble organic material. The first-stage wash removes soluble organic material and pumps high chemical oxygen demand wastewater to a pre-acidification tank prior to entering the high-rate anaerobic digester for biogas production. The second-stage wash dilutes the remaining material, where filters are used to separate out the fine cellulose from the remaining contaminants. The washed cellulose is then pumped into a stock tank. From the stock tank, the cellulose pulp is pumped as slurry into a screw press where it is de-watered to approximately a 50% solids press cake which is then pre-treated prior to being introduced to the hydrolysis system.

C. Renewable Fuel Production: The enzymatic hydrolysis stage starts when the dewatered pulp is conveyed to the pretreatment system whereby water and acid is added into a pretreatment mixer so the appropriate solids concentration and pH is obtained. Slurry from the pretreatment mixer is then pumped to the pretreatment reactor. Fiber exiting the pretreatment reactor is pumped to a medium consistency refiner and then to a screw press to be dewatered, and filtrate is returned to the mix tank. Pretreated fiber press cake is conveyed to the hydrolysis system. The pretreatment reactor, pumps, filtrate tank and screw press are connected to a Clean-in-Place ("CIP") system for regular cleaning and sterilization. The hydrolysis process is carried out within a high viscosity reactor paired with a set of mixing tanks. The pretreated fibers enter the mixing tanks along with water and enzymes, and wetted fibers circulate through the hydrolysis tank where cellulose within the fiber is converted to sugars on a batch basis.

Temperature and pH are controlled to achieve an optimum mixture which is left in the reactor where the low-temperature biological process is completed. Each reactor, pump, heat exchanger and mixing vessel is connected to a CIP system for regular cleaning and sterilization. A filter press is utilized to separate the undigested post hydrolysis solids ("PHS") from the liquid sugar solution. The sugar solution will be fed directly to the anaerobic digester for conversion into biogas.

D. Renewable Energy Production: The renewable energy production stage begins when the high organically loaded liquid is cooled and sent to an anaerobic digestion system. This system uses microorganisms to digest suspended and dissolved solids contained in the water to reduce the chemical oxygen demand of the water. Clean water and a methane-rich biogas are the byproducts of the stage. The clean water is reused in the washing process. The biogas will be used as supplementary fuel for internal energy production via a boiler and/or injected into a natural gas pipeline. Bangor Natural Gas has provided a February 10, 2016 letter stating that a section of pipe between Bangor and Hampden needs to be upgraded and that upgrades including testing will be completed prior to facility start-up.

Process water recovered from the water treatment system is used to dilute solids in the pulp and wash systems to maintain desired moisture content. A portion of the recovered water is sent to the CIP storage tank. The PHS exiting the hydrolysis filter presses, which is essentially spent fiber with a high lignin content, is processed in a specially designed combustion unit. The heat (steam) from the combustion process is recovered and sent to a steam turbine. The exhaust heat from the turbine is then used to provide process heat. The amount of electrical and heat energy generated by the biomass combustion is sufficient to provide the bulk of the energy demand for the proposed processing facility. The proposal to produce fuel grade ethanol is no longer part of the proposed processing facility project.

Plant water management is conducted via a recycling and reuse system. Purge water from the washing system and from the cook filtrate tank are blended together. Any residual fine suspended material is removed using a dissolved air flotation ("DAF") system with the highly organic liquid created sent to the anaerobic digester and the solids exiting the DAF removed using a belt press.

The solids extracted with the belt press, in the form of cake, are routed via conveyor to be disposed of offsite.

E. Industrial Co-products: The resultant products generated at the proposed processing facility will include recyclables which will be sold on the open commodities market; PHS which will be used to fuel the on-site biomass boilers; and bio-methane which will be piped to the adjacent Bangor Natural Gas Loring Pipeline. The resultant residue waste products generated at the processing facility will include materials typically 2 inches or less in size (glass and grit), large bulky items, dissolved air filtration system residues and combined boiler ash.

F. Process Benchmarks: The MRC and Fiberight have proposed operational benchmarks in a submittal dated June 2, 2016 that include evaluating the proposed process during pre-commissioning, commissioning, start-up and ramp-up. The completion of each benchmark stage will be documented with process improvements proposed as necessary.

(1) The pre-commissioning phase will include verification that systems have been installed in accordance with the applicable specifications, calibration of electrical and instrument controls, equipment alignment and energizing the electrical systems.

(2) The commissioning phase will include verification that each system can run independently and for increasing time periods.

(3) The start-up phase includes start-up of all plant systems to ensure that the systems perform in an integrated fashion. During this phase, initial volumes of MSW will be processed. Once successfully processed, MSW volumes will be increased in a stepwise fashion.

(4) The ramp-up stage includes increasing the volumes of MSW to full-scale loading. This phase is projected to occur for approximately 4 months.

The Department finds that the MRC and Fiberight have submitted adequate information regarding the proposed processing facility and process design; provided that, confirmation of natural gas pipe upgrades and testing and a finalized agreement with Bangor Natural Gas is provided to the Department at least 30 days prior to conveying bio-methane into the pipe.

18. OPERATIONS MANUAL

The MRC and Fiberight have submitted a draft operations manual for the proposed processing facility. Department staff issued final comments on April 28, 2016 regarding the draft operations manual. CES proposes to finalize the operations manual and provide it as a stand-alone document to the MRC and Fiberight after Department review and approval of the document has been completed.

The Department finds that the MRC and Fiberight have submitted an operations manual that addresses the operating requirements of 06-096 C.M.R. ch. 409, § 4; provided that, an updated operations manual is prepared and submitted for Department review and approval at least 60 days prior to full-scale operations which incorporates Department comments from an April 28, 2016 memorandum and process or equipment changes resulting from pre-commissioning, commissioning, start-up and ramp-up activities.

19. WASTE CHARACTERIZATION

Waste residues that will require initial and on-going characterization prior to final disposal include biomass boiler ash and miscellaneous process residues resulting from the DAF water treatment system. With respect to the ash characterization, the Department has requested that the MRC and Fiberight evaluate 4 roll-off containers of ash as part of the initial characterization. The MRC and Fiberight will collect composite ash samples for each of the 4 roll-off containers as part of the characterization process. Samples will be collected from the fly ash and bottom ash conveyors at specific intervals while each roll-off is being filled. The MRC and Fiberight expect the turnaround time for the analytical tests will be approximately 7 days. The MRC and Fiberight estimate that it may need to store up to 9, 30-yard roll-off containers during the initial ash characterization phase. Full roll-off containers will be stored within the proposed processing building as space allows. If the number of roll-offs exceeds the proposed processing building's capacity for inside storage, the excess roll-offs will be stored outside on the paved parking lot while waiting for receipt of laboratory analytical results. Roll-off containers that are stored outside while awaiting laboratory analytical results will be tarped to prevent infiltration of rainwater. After the initial characterization period, the MRC and Fiberight anticipate being able to store the ash roll-offs indoors.

With respect to the DAF process residues, during normal operating conditions the MRC and Fiberight expect to generate process residues at a rate of approximately 1 to 2 roll-offs daily. During initial characterization, these residues will be stored in 30-yard roll-off containers inside the proposed processing building as space allows. If the generation rate of the process residues exceeds the ability of the MRC and Fiberight to store the containerized waste indoors, the excess roll-offs will be tarped and stored outside on the paved parking surface until the MRC and Fiberight receive analytical results from the laboratory. After the initial characterization period, the MRC and Fiberight anticipate being able to store the waste roll-offs indoors.

The Department finds that the MRC and Fiberight have adequately addressed the waste characterization requirements of 06-096 C.M.R. ch. 405, § 6(C) in Section E of its draft operations manual submitted with the Application.

20. SOLID WASTE MANAGEMENT HIERARCHY

A. General: *Solid Waste Management Hierarchy*, 38 M.R.S. § 2101 establishes that it is the policy of the State to "plan for and implement an integrated approach to solid waste management" through an order of priority that places waste reduction, reuse, recycling, composting, and processing before land disposal as a "guiding principle in making decisions relating to solid waste management". Further, 06-096 C.M.R. ch. 409, § 2(C) requires the recycling or processing of all waste accepted at the facility to the maximum extent practicable, but in no case at a rate less than 50%.

B. Reduction: The MRC and Fiberight have supported and will continue to support the existence and incorporation of programs to encourage waste reduction at the source. MRC and Fiberight have demonstrated support for further waste reduction, reuse and recycling through the establishment of an express right, in the municipal contracts for MSW delivery to Fiberight, for municipalities to have the option to expand existing or future programs intending to encourage further reduction, reuse and recycling of MSW generated within its borders. Waste reduction programs are implemented at the local level by municipalities in order to reduce the quantity of waste being generated that requires municipal collection, transfer, transportation and disposal costs. The MRC and Fiberight are committed to ensure that any further arrangements supporting the development of the proposed processing facility will avoid business arrangements, such as minimum tonnage delivery guarantees set at levels that are too high or with insufficient flexibility, that might undermine or conflict with municipal efforts to reduce the amount of waste generated within their borders.

C. Reuse: MRC communities currently sponsor programs to encourage waste reuse that are implemented at the local level by municipalities with an emphasis on education, outreach, swap shops, and technical assistance to residents and the incorporation of local waste reuse programs. The MRC and Fiberight are committed to ensuring these existing programs remain in place.

D. Recycling: MRC municipalities currently sponsor a wide variety of local programs to collect, process, and market recyclables through the operation of curbside collection programs, and drop-off programs, often in connection with the operation of transfer stations and other facilities. The measures described above to support waste reduction and reuse programs will also serve to support the incorporation of local recycling. Recyclables that are not captured at the local level will subsequently be captured at the proposed processing facility. The proposed processing facility will serve to remove recyclables currently not being removed from the waste stream and will convert remaining organics into renewable products. To that end, the MRC's and Fiberight's planned system is expected to divert additional materials from the waste stream and will overall reduce the volume of MSW residues requiring land disposal. This is the first of two step increases in materials management offered by the Fiberight system compared to the existing system that strengthens conformity to the waste management hierarchy. Capturing recyclables on a regional level at a central processing facility increases the quantity of recyclable materials collected, processed and marketed and provides a new level of recycling service beyond that of existing local level programs.

E. Composting/Organics Management: Composting and other methods of processing biodegradable materials are currently being accomplished on the local level through backyard, local and/or regional composting or anaerobic digestion programs. Despite the success of a significant number of local organics composting and diversion programs, the quantities of organics remaining in the waste stream remains a significant fraction of the waste stream. This large fraction of the incoming MSW waste stream will be converted into renewable fuel products and/or biogas. This additional recycling of organics represents a second step increase in improved conformity with the waste management hierarchy compared to the existing system. Due to the proposed processing facility's expected capability to convert biodegradable waste into high value fuel products, the MRC and Fiberight are expecting some local programs may voluntarily select to transition their organics management activities to the proposed processing facility. The MWSA, described in FOF #15 above, contains provisions prohibiting, without the prior consent of Fiberight, joining member communities from initiating new or significantly and materially expanding existing programs to divert organic components from the MSW generated within its borders that otherwise would have been delivered to the proposed processing facility. The Department notes that Fiberight should annually report any such requests from joining member communities and the disposition of such requests, inclusive of the reasons for each determination. The Department further notes that Fiberight should not unreasonably withhold approval of these requests and should make reasonable efforts to replace, if needed, the quantity of removed organics with other acceptable waste.

F. Waste Processing: The MRC and Fiberight have calculated that between 70% and 80% by weight of all incoming MSW will be recycled and processed at the proposed processing facility. As part of each year's annual report, the MRC and Fiberight will need to demonstrate that all wastes accepted at the proposed processing facility have been recycled or processed into fuel for combustion to the maximum extent practicable, but in no case at a rate of less than 50%.

G. Land Disposal: The MRC and Fiberight noted that the availability of secure landfill disposal capacity is an integral part of the development of an integrated system for solid waste management in accordance with the hierarchy of management methods described above. The MRC and Fiberight estimate that between 20% and 30% by weight of all incoming waste will result in process residue that will require landfilling. The process residue includes bulky waste, textiles, DAF system residues and combined boiler ash. In addition, landfill disposal capacity will also be necessary for scheduled and unexpected shutdowns of the processing facility. As described in FOF #15 above, the MRC and Fiberight have entered into a Solid Waste Disposal Agreement with the Waste Management Disposal Services of Maine Crossroads Landfill in Norridgewock, Maine, to accept MSW Bridge Capacity waste, solid waste process residue, and MSW bypass waste for disposal.

The Department finds that the MRC and Fiberight have adequately addressed solid waste management consistent with the State's Solid Waste Management Hierarchy pursuant to 38 M.R.S. § 2101; provided that, the MRC and Fiberight: (1) annually report any requests from joining member communities to initiate new, or significantly and materially expand existing, organic diversion programs and the disposition of such requests, inclusive of the reasons for each determination; (2) do not unreasonably withhold approval to initiate new, or significantly and materially expand existing, organic diversion programs and make reasonable efforts to replace, if needed, the quantity of removed organics with other acceptable waste; and (3) submit monthly reports to the Department listing the tonnage of MSW Bridge Capacity utilized, if any is needed, and an updated schedule outlining the measures needed to reach Commercial Operation until such time as Commercial Operation is achieved.

BASED on the above Findings of Fact, and subject to the Conditions listed below, the Department makes the following CONCLUSIONS:

1. The MRC and Fiberight have planned for site design; provided that, the MRC and Fiberight submit, for Department review and approval, a complete set of construction-ready plans and documents for the proposed access road and associated utility corridor at least 30 days prior to commencing construction and a complete set of construction-ready

plans and documents for the proposed processing facility at least 60 days prior to commencing construction.

2. The MRC and Fiberight have provided adequate evidence of title, right or interest in the properties for the proposed project site; provided that, the MRC and Fiberight submit a copy of the deed(s) or executed long-term lease agreement(s) for the properties purchased and/or leased for the development of the proposed project within 30 days after the closure of sale and/or execution of the executed long-term lease agreement(s).

3. The MRC and Fiberight have complied with all of the public notice requirements of 06-096 C.M.R. ch. 2.

4. The MRC and Fiberight have provided adequate evidence of financial capacity to design, construct, operate, maintain and close the proposed processing facility in a manner consistent with state environmental regulations; provided that, the MRC and Fiberight submit for review and approval, within 30 days of receipt and prior to beginning construction of the processing facility, exclusive of the access road that is funded solely by the MRC, finalized financial documents to fund design, construction, operation, maintenance and closure of the proposed processing facility.

5. The MRC and Fiberight, and their retained consultants, have provided adequate evidence of technical ability to design, construct, operate, maintain and close the proposed processing facility in a manner consistent with state environmental regulations; provided that, the MRC and Fiberight submit to the Department for review and approval adequate evidence of the technical abilities for any additional personnel who will be responsible for operations at least 30 days prior to commencing pre-commissioning operations of the proposed processing facility.

6. The MRC and Fiberight have made adequate provisions for safe and uncongested traffic movement of all types into, out of, and within the proposed project area.

7. The MRC and Fiberight have made adequate provisions for fitting the development harmoniously into the existing natural environment; provided that, the MRC and Fiberight: (1) submit the results of the acoustical bat survey to be completed within the utility corridor; and (2) develop a timber management plan that details the management actions necessary to maintain deer winter shelter areas. The acoustical bat survey and timber management plan will be submitted at least 14 days prior to commencing construction of the proposed processing facility

8. There will be no unreasonable adverse effects on air quality and/or climate due to the proposed project.

9. The proposed processing facility will be constructed on soils suitable for the proposed use and will not cause unreasonable sedimentation or erosion of soil. The MRC and Fiberight have adequately addressed erosion and sediment control for the proposed project, and have demonstrated that the proposed project will be carried out in conformance with the approved erosion and sediment control plan, the construction contract documents, and the <u>Maine Erosion and Sediment Control Field Guide for Contractors</u>, March 2015 or its equivalent.

10. The proposed processing facility will not have an unreasonable adverse effect on surface water quality and will not unreasonably cause or increase flooding on the proposed facility site or on adjacent properties nor create an unreasonable flood hazard to any structure.

11. The proposed processing facility will not have an unreasonable adverse effect on existing uses or scenic character and will not result in increased noise.

12. The MRC and Fiberight have provided for adequate utilities and will have no unreasonable adverse effect on existing or proposed utilities in the municipality or area served by utilities; provided that: (1) the MRC and Fiberight submit copies of the Bangor WWTP Industrial User Permit and letter approving the operation of a wastewater pre-treatment system, if necessary, to the Department within 30 days of receipt and (2) the MRC and Fiberight submit, for review and approval, the final design for the on-site wastewater storage tanks at least 60 days prior to construction of the proposed processing facility.

13. The proposed processing facility will not pose an unreasonable threat to the quality of a significant sand and gravel aquifer and will not result in unreasonable adverse effects on groundwater.

14. The MRC and Fiberight have submitted adequate information regarding the proposed processing facility and process design; provided that, confirmation of natural gas pipe upgrades and testing and the finalized agreement with Bangor Natural Gas is provided to the Department at least 30 days prior to conveying bio-methane into the pipe.

15. The MRC and Fiberight have submitted an operations manual that addresses the operating requirements of 06-096 C.M.R. ch. 409, § 4; provided that, an updated operations manual is prepared and submitted at least 60 days prior to full-scale operations to incorporate Department comments from an April 28, 2016 memorandum and process or equipment changes resulting from pre-commissioning, commissioning, start-up and ramp-up activities.

16. The MRC and Fiberight have adequately addressed the waste characterization requirements of 06-096 C.M.R. ch. 405, § 6(C) in their operations manual.

17. The MRC and Fiberight have adequately addressed solid waste management consistent with the State's Solid Waste Management Hierarchy pursuant to 38 M.R.S. § 2101; provided that, the MRC and Fiberight: (1) annually report any requests from joining member communities to initiate new, or significantly and materially expand existing, organic diversion programs and the disposition of such requests, inclusive of the reasons for each determination; (2) do not unreasonably withhold approval to initiate new, or significantly and materially expand existing, organic diversion programs and make reasonable efforts to replace, if needed, the quantity of removed organics with other acceptable waste; and (3) submit monthly reports to the Department listing the tonnage of MSW Bridge Capacity utilized, if any is needed, and an updated schedule outlining the measures needed to reach Commercial Operation until such time as Commercial Operation is achieved.

THEREFORE, the Department APPROVES the noted application of the Municipal Review Committee and Fiberight, LLC SUBJECT TO THE FOLLOWING CONDITIONS and all applicable standards and regulations:

1. The applicable Standard Conditions of Approval, a copy attached as Appendix A.

2. The invalidity or unenforceability of any provision, or part thereof, of this license shall not affect the remainder of the provision or any other provisions. This license shall be construed and enforced in all respects as if such invalid or unenforceable provision or part thereof had been omitted.

3. At least 30 days prior to commencing construction of the access road and associated utility corridor and at least 60 days prior to commencing construction of the proposed processing facility, the MRC and Fiberight shall submit a complete set of construction-ready plans and documents for each component of the proposed project to the Department for review and approval.

4. Within 30 days after the closure of sale and/or the execution of the long-term lease agreement(s) has occurred, the MRC and Fiberight shall submit a copy of the deed(s) or executed long-term lease agreement(s) for the properties purchased and/or leased for the development of the proposed project.

5. Within 30 days of receipt and prior to beginning construction of the proposed processing facility, the MRC and Fiberight shall submit to the Department for review and approval the finalized financial documents to fund design, construction, operation, maintenance and closure of the proposed processing facility.

6. At least 30 days prior to commencing pre-commissioning operations of the proposed processing facility, the MRC and Fiberight shall submit to the Department for review and approval adequate evidence of the technical abilities for personnel who will be responsible for operations of the proposed processing facility.

7. At least 30 days prior to conveying bio-methane into the natural gas pipe, the MRC and Fiberight shall submit to the Department confirmation of pipe upgrades and testing and the finalized agreement with Bangor Natural Gas.

8. At least 14 days prior to commencing construction of the proposed processing facility, the MRC and Fiberight shall submit the acoustical bat survey of the utility corridor and a timber management plan to maintain deer winter shelter areas.

9. Within 30 days of receipt, the MRC and Fiberight shall submit the Bangor WWTP Industrial User Permit and letter approving the operation of a wastewater pre-treatment system, if necessary, and within 60 days prior to construction of the proposed processing facility, the MRC and Fiberight shall submit, for Department review and approval, the final design for the on-site wastewater storage tanks.

10. At least 60 days prior to commencing full-scale operations, an updated operations manual which incorporates Department comments from an April 28, 2016 memorandum and process or equipment changes resulting from pre-commissioning, commissioning, start-up and ramp-up activities shall be submitted to the Department for review and approval.

11. As part of the Annual Report, the MRC and Fiberight shall report any requests from joining member communities to initiate new, or significantly and materially expand existing, organic diversion programs and the disposition of such requests, inclusive of the reasons for each determination. The MRC and Fiberight shall not unreasonably withhold approval to initiate new, or significantly and materially expand existing, organic diversion programs and make reasonable efforts to replace, if needed, the quantity of removed organics with other acceptable waste.

12. The MRC and Fiberight shall submit monthly reports to the Department listing the tonnage of MSW Bridge Capacity utilized, if any is needed, and an updated schedule outlining the measures needed to reach Commercial Operation until such time as Commercial Operation is achieved.

MUNICIPAL REVIEW COMMITTEE, INC. AND	34	SOLID WASTE
FIBERIGHT, LLC	)	LICENSE
HAMPDEN, PENOBSCOT COUNTY, MAINE	)	
SOLID WASTE PROCESSING FACILITY	)	
#S-022458-WK-A-N	)	
(APPROVAL WITH CONDITIONS)	)	NEW LICENSE

DONE AND DATED AT AUGUSTA, MAINE, THIS 14th DAY OF July, 2016.

DEPARTMENT OF ENVIRONMENTAL PROTECTION

BY: [signature] for
PAUL MERCER, COMMISSIONER

PLEASE NOTE ATTACHED SHEET FOR GUIDANCE ON APPEAL PROCEDURES.

Date of initial receipt of application: June 24, 2015
Date of application acceptance: July 15, 2015

Date filed with Board of Environmental Protection:

Filed
JUL 14 2016
State of Maine
Board of Environmental Protection

XLP79433/

BGS/NEV/SME 49

Submit to: Maine DEP
Attn: Geraldine Travers
17 State House Station
Augusta, Maine 04333

Due annually by February 28th

Annual Report Form
for facilities with
SOLID WASTE PROCESSING LICENSES
including those with BENEFICIAL USE LICENSES

For YEAR: 2015

Name of Facility: ReEnergy Lewiston, LLC

Location address: 38 Alfred A Plourde Parkway, Lewiston, Maine 04240

E-mail: jgrant@reenergyholdings.com

DEP Processing Facility License Number(s):	DEP Beneficial Use License Number(s):
S- 013266-WX-H-T	S-
S- 013266-WK-G-A	S-
S- 013266-WK-F-M	S-
S- 013266-WK-E-R	S-
S-	S-

Facility Operator: Jason Grant, General Manager Email: JGrant@reenergyholdings.com Phone: (207) 783-2941

Facility Operator mailing address: Same as facility

Contractor Contact: Peter Mohlin, St.Germain Collins Email: peterm@stgermaincollins.com Phone: (207) 591-7000

Billing Contact: Karen Buresh Email: KBuresh@reenergyholdings.com Phone: (518) 810-0221

1. Description of all wastes accepted at the facility:

A. Enter the number or description of each waste type received and the amount (by weight) of each waste type **by state or province of origin**. If measured weight is not available, indicate waste volume and density used to calculated weight entered in the "Explanatory notes and comments" field at the bottom of the table. Please attach in-coming shipment records as available.

Please use the following waste types as applicable to your facility:

1. Mixed CDD (may include building materials, furniture and carpet, asphalt, wall board, pipes, metal conduit, etc.)
2. Landclearing debris (brush, stumps, bark)
3. Clean lumber (free from metals, plastics and coatings)
4. Treated wood
5. Asphalt roofing & shingles
6. Sheetrock/wallboard/gypsum
7. Furniture
8. Carpet
9. Glass (describe type or source)
10. Metals - ferrous
11. Metals - non-ferrous
12. Metals - mixed
13. Tires
14. Vehicle batteries
15. Plastics
16. Mixed paper & corrugated cardboard (OCC)
17. Coal, oil or multifuel boiler ash
18. Oil-contaminated soil, gravel, other aggregate
19. Sandblast grit
20. Catch basin grit & street sweepings
21. Other (describe)

Waste type received	Origin by state or province	Amount received (break out by state/province)	Amount processed	Unit of Measure
Mixed CDD	ME	17,230.50		Tons
Mixed CDD	MA	150,986.74		Tons
Mixed CDD	NH	1,131.09		Tons
Clean Lumber	ME	7,040.24		Tons
Clean Lumber	MA	4,742.24		Tons
Clean Lumber	NH	208.12		Tons

Explanatory notes and comments:

ReEnergy Lewiston maintains scale records on-site for all incoming shipments. The records are available for Maine DEP review upon request.

B. In-coming waste characterization. Attach results and a summary of all in-coming waste characterization events conducted in the reporting calendar year. This must include all data and results of the characterization of all wastes accepted at the facility, as well as the totals of data from your completed waste characterization forms (e.g., "Data Analysis Form" or other approved form) used to quantify by weight the recyclable and non-recyclable content of waste materials accepted for processing at the facility. (This item is not applicable to processing facilities that do not generate residues requiring disposal.)

C. Amount of products shipped for beneficial use. Enter the number or description of each of the following processing product shipped, the amount shipped and the destination (users or facility). If you are using the material on-site, list the destination as "on-site". Please use the following descriptors:

a. CDD wood fuel chip
b. Wood fuel chip
c. Wood chip for landscaping
d. Erosion control mix
e. Tire fuel chip
f. Tire chip for engineered applications
g. Other (describe)

Description of processing products	Weight	Unit of measure	Destination – user or facilities
CDD Wood Fuel Chip	2,223.68	Tons	Lincoln Pulp and Paper - Lincoln, ME
CDD Wood Fuel Chip	244.57	Tons	SAPPI - Westbrook, ME
CDD Wood Fuel Chip	1,095.77	Tons	Krugar - QC, Canada
Other - CDD Process Fines as ADC	19,914.66	Tons	City of Lewiston, ME
Other - CDD Process Fines as ADC	108,383.92	Tons	Juniper Ridge Landfill - ME
CDD Wood Fuel Chip	2,544.37	Tons	ecomaine - Portland, ME
Other - CDD Residue - Bulky Waste Fuel	434.63	Tons	Mid-Maine Waste (MMWAC) - Auburn, ME
CDD Wood Chip	1,524.47	Tons	Tafisa Canada Inc. - QC, Canada

D. Residue characterization. Attach results and a summary of all out-going waste residue characterization events conducted in the reporting calendar year. This must include all data and results of the characterization of all waste residues shipped from the facility for disposal. (This item is not applicable to processing facilities that do not generate residues requiring disposal.)

Two waste residue characterization events were conducted in May and December 2015. Results indicate the fines meet Maine DEP requirements. The laboratory results are attached.

E. Summary of recyclables and residue wastes shipped. Enter the description and amounts of any recyclables and wastes that were shipped off-site, and the destination facilities.

Recyclable or waste type (use types as listed in 1.A)	**Destination State or Province**	**Weight**	**Unit of Measure**	**Destination facility**
Aggregate	ME	2,076.87	Tons	City of Lewiston Quarry
Metals - Ferrous	NH	2,973.15	Tons	LL&S
Metals - Ferrous	ME	1,621.37	Tons	Schnitzer Northeast
Metals - Ferrous	ME	643.94	Tons	Maine Metals
Metals - Non-Ferrous	ME	57.97	Tons	AIM Recycling
Metals - Non-Ferrous	ME	143.18	Tons	Schnitzer Northeast
Metals - Non-Ferrous	ME	242.92	Tons	Maine Metals
CDD Residue - Bulky Waste	ME	47,193.06	Tons	Juniper Ridge Landfill
Other - see attached Addenda				

F. Recycling and beneficial use demonstration. Describe and demonstrate that all wastes accepted at the facility have been recycled or processed into fuel for combustion to the maximum extent practicable. For this demonstration, "recycle" includes but is not limited to: reuse of waste as shaping, grading or alternative daily cover at landfills; aggregate material in construction; and boiler fuel substitutes. This must include:

- A narrative with a detailed comparison of the wastes accepted at the facility, products and secondary materials produced for recycling/reuse, and residues leaving the facility for disposal.
- A calculated recycling rate for the past year, and a discussion of this recycling rate, including a specific explanation of why that rate represents recycling to the maximum extent practicable, and an explanation and justification for why wastes and residues disposed over the preceding year could not be recycled or reused.
- A demonstration that the facility and its operations are consistent with the recycling provisions of the state waste management and recycling plan as defined at 38 MRS §1303-C(35).

(This item is not applicable to processing facilities that do not generate residues requiring disposal.)

See attached Addenda.

G. Summary of end-of-year on-site storage. Enter the amounts of products, recyclables, and wastes stored on site as of 12/31.

<table>
<tr><th>Type of product, recyclables and waste stored on site as of 12/31</th><th>Weight (tons)</th><td rowspan="8">(If converting from cubic yards, use conversion factors from Table 1 of Characterization of Construction/Demolition Debris by the Visual Estimation Method for Use by Solid Waste Processing Facilities, available on-line at www.maine.gov/dep/waste/solidwaste/index.html under "Additional Information and Guidance".</td></tr>
<tr><td>In-Bound CDD</td><td>1,793</td></tr>
<tr><td>CDD Processing Residue - Fines</td><td>90</td></tr>
<tr><td>CDD Processing Residue - Bulky Waste</td><td>140.4</td></tr>
<tr><td>In-Bound Clean Lumber</td><td>440.6</td></tr>
<tr><td>Metal - Ferrous</td><td>18</td></tr>
<tr><td>Aggregate</td><td>6</td></tr>
<tr><td>Additional information is provided in the attached Addenda</td><td></td></tr>
</table>

2. Operations

Provide a summary of the processing operation including: a summary of complaints received by the facility during the previous year, a discussion of any odor problems, and any other problems encountered, and follow-up actions taken to address complaints and other identified problems.

See attached Addenda.

3. Alterations to the facility operations and site

A description of changes to the facility site or operations that have occurred during the reporting year, and as-built plans as applicable. Also, changes to minor aspects of the facility site proposed to be changed in the current year may be described.

See attached Addenda.

4. Monitoring (if facility has a monitoring plan).
A summary and evaluation of past year's monitoring results, monitoring program and equipment; recommended changes may be submitted. Attach additional sheets or provide a separate attachment if additional space is needed.

Monitoring Results

ReEnergy Lewiston conducted stormwater monitoring in accordance with the Maine DEP's Multi-Sector General Permit for stormwater discharges associated with an industrial activity. The 2015 quarterly compliance evaluations and visual monitoring results are attached.

Monitoring Program

The Monitoring Program was determined to be effective based on quarterly and annual reviews.

Equipment

No equipment changes are recommended at this time.

Proposed changes (if any)

None.

I have examined this report and to the best of my knowledge and believe, said report is true, correct and complete.

Signature of person completing this form ____

Printed name of person completing this form PETER MOHLIN, ST.GERMAIN COLLINS

PLEASE ATTACH ADDITIONAL PAGES AS NEEDED

ReEnergy Lewiston
38 Alfred A Plourde Pkwy
Lewiston, ME 04240

P: (207) 783-2941
F: (207) 784-9852
www.reenergyholdings.com

ADDENDA TO REVISED 2015 ANNUAL REPORT FORM for facilities with SOLID WASTE PROCESSING LICENSES including those with BENEFICIAL USE LICENSES

1.B. In-coming waste characterization

Monthly summaries and results of all in-coming waste characterization events are attached.

1.D. Residue characterization

Laboratory results for residue characterization are attached.

1.E. Summary of recyclables and residue wastes shipped

Other waste types	Destination	Weight	Unit	Destination Facility
CFC's Evac.	ME	55	Ea.	Ozone Savers
CRT's/ TV's	NH	4.43	Tons	North Coast Services
Medical Sharps	ME	14	cf	Stericycle
Fluorescent Bulbs, 4-foot	ME	39	Ea.	Gilman's Electrical Supply
HIV Lamps	ME	0	Ea.	"
Mercury Switches	ME	0	Ea.	"
Tanks w/Propane	ME	387	Ea.	Lavigne's Cleaning Service
Lead Batteries	ME	9506	lbs.	Schnitzer
NI-CD Batteries	ME	327	lbs.	Call2recycle

1.F. Recycling and beneficial use demonstration

- ***A narrative with a detailed comparison of the wastes accepted at the facility, products and secondary materials produced for recycling/reuse, and residues leaving the facility for disposal.***

Mechanical and manual sorting activities separate out wood for beneficial use (fuel) from the construction and demolition debris (CDD) at the ReEnergy Lewiston (REL) facility. The positive-pick wood recovery process implemented at REL in 2013 has continued throughout 2015.

- ***A calculated recycling rate for the past year, and a discussion of this recycling rate, including a specific explanation of why that rate represents recycling to the maximum extent practicable, and an explanation and justification for why wastes and residues disposed over the preceding year could not be recycled or reused.***

The overall facility recycling rate was 78.7% for 2015. Of this, approximately 3.2% was CDD boiler fuel, 66% was Alternative Daily Cover (ADC) material, 1.1% aggregate, 4% metals and <0.01% of other recyclables (TVs, electronics, batteries). 21.3% were non-recyclable process residuals (bulky wastes) that currently have no beneficial reuse market, such as furniture, plastics, insulation, carpet and other materials.

The approximate 3% decrease in CDD boiler fuel shipments in 2015 compared to 2014 can be attributed to lower market demand. CDD Wood Fuel was not sent to ReEnergy Livermore nor New Page – Rumford in 2015. Recognizing the lower CDD Wood Fuel demand, REL sought new markets and shipped 20% of its wood chip product to a fiberboard manufacturer (Tafisa) located in Canada.

- ***A demonstration that the facility and its operations are consistent with the recycling provisions of the state waste management and recycling plan as defined at 38 MRS §1303-C(35)***

The 78.7% recycling/beneficial reuse rate exceeds the recycling requirement minimum of no less than 50%. The facility continues to improve its recycling rates with use of its "hand pick" lines, and the continued use of an overband magnet on the fines line to increase metal recovery which was implemented in 2014.

1.G. Summary of end-of-year on-site storage

End of year on-site storage calculations are attached.

2. Operations Summary

- ***Provide a summary of the processing operation including: a summary of complaints received by the facility during the previous year, a discussion of any odor problems, and any other problems encountered, and follow-up actions taken to address complaints and other identified problems.***

The REL facility was in operation all 12 months of 2015. Based on in-bound scale weights, a total of 181,338 tons of CDD was received from sources in Maine, New Hampshire and Massachusetts. The end of year inventory was 2,488 tons, approximately 843 tons more than the end of 2014. The total scaled weight of outbound materials leaving the REL facility was 191,327 tons. The 5.2% increase in weight between materials accepted is within range of what other CDD processing facilities experience. The main reason for the increase is due to the material absorbing water (rainfall, snowmelt) while onsite being processed.

There were no dust or odor problems reported by the facility's abutters in 2015. The facility's stormwater management system, implemented in 2014, functioned properly as designed. Routine maintenance was performed (sediment removal) from the facility's stormwater control and containment structures, as documented in the quarterly stormwater compliance evaluation reports attached. No oil and/or chemical spills occurred at the facility in 2015.

3. Alterations to the facility operations and site

- ***A description of changes to the facility site or operations that have occurred during the reporting year, and as-built plans as applicable. Also, changes to minor aspects of the facility site proposed to be changed in the current year may be described.***

In 2015, REL determined it could process CDD wood fuel using two methods, depending on operating conditions. A portable wood chipper is brought onsite to process batch loads, or the facility operates its stationary wood processing line to process larger loads. Wood is positively picked from the OEM machine set-up and stockpiled for processing by both methods.

REL also ran pilot operations in 2015 to further process the CDD fines from the OEM in order to increase recycling of high value metals and aggregate, with the goal of creating a boiler fuel product for waste-to-energy incineration facilities. REL is currently evaluating the results of the tests and developing plans to further refine its recovery processes in 2016.

No physical changes to the site occurred in 2015.

4. Monitoring results

Stormwater monitoring reports are attached.

BGS/NEWSME 50

Submit to: **Maine DEP**
Attn: Geraldine Travers
17 State House Station
Augusta, Maine 04333

Due annually by February 28th

Annual Report Form
for facilities with
SOLID WASTE PROCESSING LICENSES
including those with BENEFICIAL USE LICENSES

For YEAR: 2015

Name of Facility: Aggregate Recycling Corp.

Location address: 434 Dow Highway, Eliot, ME

E-mail: info@aggregaterecycling.com

DEP Processing Facility License Number(s):	**DEP Beneficial Use License Number(s):**
S- 021818-WK-B-N	S- 020744-WM-T-N
S-	S- 021818-WK-D-P
S-	S- 020744-WL-K-N
S-	S-
S- 021818-WK-C-N	S- 021818-WL-F-N

Facility Operator: John Doherty Email: info@aggregaterecycling.com Phone: 439-5584

Facility Operator mailing address: P.O. Box 363, Eliot, ME 03903

Contractor Contact: N/A Email: Phone:

Billing Contact: Ericka Stevens Email: accounting@aggregaterecycling.com Phone: 439-5584

1. **Description of all wastes accepted at the facility:**

A. Enter the number or description of each waste type received and the amount (by weight) of each waste type **by state or province of origin.** If measured weight is not available, indicate waste volume and density used to calculated weight entered in the "Explanatory notes and comments" field at the bottom of the table. Please attach in-coming shipment records as available.

Facility: Aggregate Recycling Corp. Reporting Year: 2015

Please use the following waste types as applicable to your facility:

1. Mixed CDD (may include building materials, furniture and carpet, asphalt, wall board, pipes, metal conduit, etc.)
2. Landclearing debris (brush, stumps, bark)
3. Clean lumber (free from metals, plastics and coatings)
4. Treated wood
5. Asphalt roofing & shingles
6. Sheetrock/wallboard/gypsum
7. Furniture
8. Carpet
9. Glass (describe type or source)
10. Metals - ferrous
11. Metals - non-ferrous
12. Metals - mixed
13. Tires
14. Vehicle batteries
15. Plastics
16. Mixed paper & corrugated cardboard (OCC)
17. Coal, oil or multifuel boiler ash
18. Oil-contaminated soil, gravel, other aggregate
19. Sandblast grit
20. Catch basin grit & street sweepings
21. Other (describe)

Waste type received	Origin by state or province	Amount received (break out by state/province)	Amount processed	Unit of Measure
1. Mixed CDD	ME	15,510	all	tons
	NH	8,967	all	tons
	MA	541	all	tons
2. Landclearing debris	ME	133	all	tons
	NH	63	all	tons
	MA	244	all	tons
4. Treated Wood	ME	131	all	tons
	NH	79	all	tons
	MA	810	all	tons
5. Asphalt Shingles	ME	1,411	all	tons
	NH	647	all	tons
6. Sheetrock/gypsum	NH	330	all	tons
17. Coal Ash	NH	2,976	all	tons
	MA	6,013	all	tons
	CT	403	all	tons
18. Oil-Contaminated Soil	ME	1,724	all	tons
	NH	7,059	all	tons
	MA	66,838	all	tons
19. Sandblast Grit	ME	2,096	all	tons
	NH	14	all	tons
	MA	2,342	all	tons
21. Waste Wood	ME	1,348	all	tons
	NH	948	all	tons
	MA	196	all	tons

Explanatory notes and comments:

Facility: Aggregate Recycling Corp. Reporting Year: 2015

B. In-coming waste characterization. Attach results and a summary of all in-coming waste characterization events conducted in the reporting calendar year. This must include all data and results of the characterization of all wastes accepted at the facility, as well as the totals of data from your completed waste characterization forms (e.g., "Data Analysis Form" or other approved form) used to quantify by weight the recyclable and non-recyclable content of waste materials accepted for processing at the facility. (This item is not applicable to processing facilities that do not generate residues requiring disposal.) See attached

C. Amount of products shipped for beneficial use. Enter the number or description of each of the following processing product shipped, the amount shipped and the destination (users or facility). If you are using the material on-site, list the destination as "on-site". Please use the following descriptors:

a. CDD wood fuel chip
b. Wood fuel chip
c. Wood chip for landscaping
d. Erosion control mix
e. Tire fuel chip
f. Tire chip for engineered applications
g. Other (describe)

Description of processing products	Weight	Unit of measure	Destination – user or facilities
CDD Wood fuel chip	2,506	tons	Tafisa, Lac Magentic, PQ
Erosion Control mix	400	tons	adjacent land
Ground Asphalt Shingles (RAS)	2,416	tons	paving contractor; New Brunswick
Scrap Metals	321	tons	Schnitzer / Berwick Iron

D. Residue characterization. Attach results and a summary of all out-going waste residue characterization events conducted in the reporting calendar year. This must include all data and results of the characterization of all waste residues shipped from the facility for disposal. (This item is not applicable to processing facilities that do not generate residues requiring disposal.)

None

Facility: Aggregate Recycling Corp. Reporting Year: 2015

E. Summary of recyclables and residue wastes shipped. Enter the description and amounts of any recyclables and wastes that were shipped off-site, and the destination facilities.

Recyclable or waste type (use types as listed in 1.A)	**Destination State or Province**	**Weight**	**Unit of Measure**	**Destination facility**
Processed CDD	ME	8,209	tons	Juniper Ridge Landfill
Ground CDD	ME	17,025	tons	"
CDD Fines	ME	2,376	tons	"
Demo Wood Chip	ME	141	tons	"
Sheetrock/Gypsum	NH	330	tons	Berlin Landfill
E-waste (incidental)	NH	1	ton	North Coast Services

F. Recycling and beneficial use demonstration. Describe and demonstrate that all wastes accepted at the facility have been recycled or processed into fuel for combustion to the maximum extent practicable. For this demonstration, "recycle" includes but is not limited to: reuse of waste as shaping, grading or alternative daily cover at landfills; aggregate material in construction; and boiler fuel substitutes. This must include:

- A narrative with a detailed comparison of the wastes accepted at the facility, products and secondary materials produced for recycling/reuse, and residues leaving the facility for disposal.
- A calculated recycling rate for the past year, and a discussion of this recycling rate, including a specific explanation of why that rate represents recycling to the maximum extent practicable, and an explanation and justification for why wastes and residues disposed over the preceding year could not be recycled or reused.
- A demonstration that the facility and its operations are consistent with the recycling provisions of the state waste management and recycling plan as defined at 38 MRS §1303-C(35).

(This item is not applicable to processing facilities that do not generate residues requiring disposal.)

Please see attached

Facility: Aggregate Recycling Corp.

Reporting Year: 2015

G. Summary of end-of-year on-site storage. Enter the amounts of products, recyclables, and wastes stored on site as of 12/31.

Type of product, recyclables and waste stored on site as of 12/31	Weight (tons) +/-	
CDD Debris Processed CDD	250 tons 100 tons	(If converting from cubic yards, use conversion factors from Table 1 of *Characterization of Construction/Demolition Debris by the Visual Estimation Method for Use by Solid Waste Processing Facilities*, available on-line at www.maine.gov/dep/waste/solidwaste/index.html under "Additional Information and Guidance".
Demo Woodwaste Demo Wood Chips	100 tons 50 tons	
Landclearing Debris/Brush Erosion Control	25 tons -- 0 --	
Concrete/Brick/Ledge Crushed stone/gravel	10,000 tons 2,000 tons	
Asphalt Shingles Ground Shingles (R.A.S.)	6,500 tons 50 tons	
Oil-impacted Soil Recycled Soil	2,000 tons 15,000 tons	

2. Operations

Provide a summary of the processing operation including: a summary of complaints received by the facility during the previous year, a discussion of any odor problems, and any other problems encountered, and follow-up actions taken to address complaints and other identified problems.

There were no complaints or odor problems attributable to the facility or operations.

3. Alterations to the facility operations and site

A description of changes to the facility site or operations that have occurred during the reporting year, and as-built plans as applicable. Also, changes to minor aspects of the facility site proposed to be changed in the current year may be described.

The demolition woodwaste storage area was paved in order to keep woodwaste clean and improve product quality. A portion of the gravel road was paved (to behind the shop) to reduce dust. A grinder was added to CDD processing to remove more metal and reduce truck trips by sizing materials better and maximizing weights on outbound trucks.

Facility: Aggregate Recycling Corp. Reporting Year: 2015

4. Monitoring (if facility has a monitoring plan).
A summary and evaluation of past year's monitoring results, monitoring program and equipment; recommended changes may be submitted. Attach additional sheets or provide a separate attachment if additional space is needed.

Monitoring Results

See attached SWPPP Visual Monitoring Forms.

Monitoring Program Quarterly outfall sampling of stormwater ponds in accordance with license #S-021818-WK-B-N and SWPPP.

Equipment

N/A

Proposed changes (if any) None

I have examined this report and to the best of my knowledge and believe, said report is true, correct and complete.

Signature of person completing this form [signature]

Printed name of person completing this form John J. Doherty

PLEASE ATTACH ADDITIONAL PAGES AS NEEDED

B. Incoming Waste Characterization Summary:

Total Tons Characterized: 210.75 Tons

State of Origin: ME: 68% NH: 27% MA: 5%

Unsorted / Sorted Load: Unsorted: 54% Sorted: 46%

Nature of Material:	New Construction:	9%		
	Roofing:	9%		
	Remodel/Renovatior	16%		
	Demolition:	49%		
	Other:	16%		
		100%		
Generator Type:	Transfer Station:	22.0%		
	Commercial/Industri	58.5%		
	Residential:	19.5%		
	Other:	0.0%		
		100%		
Main Material Class:	Paper:	13.34	tons	6.3%
	Plastic:	10.17	tons	4.8%
	Metal:	6.19	tons	2.9%
	Wood:	87.92	tons	41.7%
	Aggregate:	51.12	tons	24.3%
	Roofing:	18.23	tons	8.7%
	Gypsum:	8.37	tons	4.0%
	Organics:	0.24	tons	0.1%
	Insulation:	8.16	tons	3.9%
	Carpet:	0.28	tons	0.1%
	Other:	6.73	tons	3.2%
		210.75	tons	100.0%

F. Recycling & Beneficial Use Calculation

2015 Recycling Rate Calculation:

1.) Material Types Received For Recycling

Material Types Received For Recycling	Tons
Concrete/Brick/Ledge, etc.	7,545
Demo Woodwaste/Scrap Lumber	2,532
Asphalt Shingles	2,058
Landclearing Debris (stumps, brush)	440
Total from above	**12,575**

2.) Additional CDD Materials Recycled

Additional CDD Materials Recycled	Tons
Scrap Metals Recycled	321
Incidental E-waste Recycled	1
Total from above	**322**

3.) Additional CDD Materials Utilized as Daily Cover

Additional CDD Materials Utilized as Daily Cover	Tons
Demo Wood Chip Cover	141
CDD Process Fines	2,376
CDD Ground Cover	17,025
Total from above	**19,542**

4.) We can also estimate the total amount of woodwaste removed and recycled from Mixed CDD:

+/- 300 tons

Total of Materials Recycled/Re-used = 12,575 + 322 + 19,542 + 300 = approx. 32,739 tons.

1.) Total of CDD Materials Not Recycled

Total of CDD Materials Not Recycled	Tons
Mixed CDD Received	26,038
Less scrap metal removed/recycled	(321)
Less incidental E-waste removed/recycled	(1)
Less woodwaste removed/recycled	(300)
Less CDD utilized as Daily Cover (ADC)	(19,401)
Total	**6,015**

Recycling Rate = 84% (32,739 tons / [32,739 + 6,015] tons)

The facility recycles and processes CDD materials to the maximum extent practicable and is consistent with the recycling provisions of the state waste management and recycling plan.

Source separated materials received by the facility are detailed in section 1 above. The Mixed CDD building was expanded and improved with a concrete floor added late in 2014, which added space for processing and sorting,while greatly reducing the amount of dirt and water (weight) being loaded out with materials requiring disposal. With source materials now cleaner, a grinder was added in 2015 providing increased metals recovery and improved processing abilities.

Sevee, John E.

**PRE-FILED REBUTTAL TESTIMONY OF JOHN E. SEVEE P.E. C.G.
BEFORE THE BOARD OF ENVIRONMENTAL PROTECTION
REGARDING DIRECT TESTIMONY OF EDWARD S. SPENCER
JUNIPER RIDGE LANDFILL EXPANSION
MEDEP APPLICATIONS #S-020700-WD-BI-N & #L-024251-TG-C-N**

This rebuttal testimony addresses statements contained in Edward Spencer's direct testimony on the Juniper Ridge Landfill (JRL) Expansion application filed by the Bureau of General Services (BGS) and NEWSME Landfill Operations, LLC (NEWSME). I am addressing Mr. Spencer's statement concerning site geology and the effect of the earth rebounding from the last glacial ice sheet on the JRL Expansion (see Spencer Testimony at 5). On that same page, Mr. Spencer also has questioned the potential subsidence of the site due to waste loadings.

Glacial rebound will have no effect on either the integrity of the landfill or the sloping of drainage pipes since the crustal rebound is occurring over the entire region surrounding the landfill. As a result, there will be no significant differential movement within the landfill site that would affect the liner or drainage pipe slopes of the Expansion. The overall integrity of the Expansion due to crustal rebound is addressed in the application with an evaluation of the landfill stability for both static and seismic loading conditions. This is covered in Volume III, Section 3.1 of the application. As shown by that analysis the Expansion has been designed to meet the factors of safety required by the Rules.

Mr. Spencer's comparison of historic overburden pressures associated with a mile of glacial ice over one acre of land versus the total yearly tonnage received at the landfill has no value in the evaluation of actual ground loadings (i.e., weight of waste placed per unit area) associated with the Expansion and potential foundation soil settlements. Mr. Spencer's analysis compares pressures (weight per unit area) with total mass (just the weight of the waste without dividing by the area over which the waste is placed). These two values cannot be compared in a meaningful way. The actual landfill pressure is about two to three percent of the pressure caused by the glacial ice. Thus, the glacial pressures on the foundation soils and bedrock was about fifty times greater than the landfill pressures. Therefore the actual landfill pressures represent an insignificant increase from current conditions with regard to landfill settlement. Volume III, Section 3.1.3 of the Application addresses actual ground pressures associated with the Expansion and the anticipated foundation settlement from these pressures. The foundation soils settlement was calculated to range between 0.0 and 0.3 feet with the largest settlement occurring in the northeastern portion of the Expansion where the combination of the waste thickness and foundation soil thickness are greatest. This calculation is based on actual soil properties as defined through borings into the foundation soils and bedrock. This analysis was completed to evaluate whether the foundation soil settlements would affect the landfill's performance. The finding of this analysis is that these settlements would not compromise the performance of the Expansion's liner or leachate collection systems, and the base slopes are expected to change less than 0.1% from the design slopes as a result of waste loading.

Dated: 9/7/16

John E. Sevee

John E. Sevee, P.E.

STATE OF MAINE

Cumberland, ss.

Personally appeared before me the above-named John E. Sevee and made oath that the foregoing is true and accurate to the best of his knowledge and belief.

Before me,

Dated: 9/7/16

Holly A. Brooks

Notary Public

Name:

My Commission Expires:

HOLLY A. BROOKS
Notary Public, Maine
My Commission Expires July 17, 2017

Booth, Michael S.

PRE-FILED REBUTTAL TESTIMONY OF MICHAEL S. BOOTH
BEFORE THE BOARD OF ENVIRONMENTAL PROTECTION
REGARDING DIRECT TESTIMONY OF EDWARD S. SPENCER AND STEVE COGHLAN
JUNIPER RIDGE LANDFILL EXPANSION
MEDEP APPLICATIONS #S-020700-WD-BI-N & #L-024251-TG-C-N

This rebuttal testimony addresses several statements contained in Edward Spencer's and Steve Coghlan' s July 29, 2016, direct testimony on the Juniper Ridge Landfill (JRL) Expansion application filed by the Bureau of General Services (BGS) and NEWSME Landfill Operations, LLC (NEWSME). The items I will address are associated with the design of the Expansion and consist of statements, many phrased as questions, contained in their testimony relating to the adequacy of the Expansion's leachate management systems, landfill gas and leachate piping, liner performance, and stormwater management systems. In addressing these statements I have identified where in the application information is presented, or have provided additional information to demonstrate that their concerns are addressed by the siting and design of the Expansion, or that the criteria they suggest be applied to the Expansion design go well beyond the requirements contained in the Solid Waste Management Rules (Rules).[1]

I. MR. EDWARD SPENCER

Leachate Collection System: Mr. Spencer questions how much redundancy is built into the leachate collection system, what would happen if a multiday rain event were combined with a power outage, and whether the system can hold the additional liquid (see Spencer Testimony at 6).

The Expansion design and operations incorporate a number of redundancies and features to address Mr. Spencer's concerns. First, JRL has a backup generator to supply power to the leachate pumping systems in the event of a power outage. Second, clean surface water runoff from non-active areas (i.e., areas where intermediate cover has been placed) is diverted away from the leachate collection system as a standard operating procedure. This limits the volume of leachate generated by the facility, and the amount of rainfall that is handled by the leachate collection system. Third, leachate generated within the active operating areas of the landfill is collected in internal cell

[1] The Third Procedural Order specifically states "Parties are cautioned, however, that the Board will make its decision based on licensing criteria in statute and rule, and that the Board has no authority in this proceeding to alter the licensing criteria." (see Third Procedural Order at 5.)

leachate storage sumps and then pumped to an onsite storage tank. These internal storage sumps are sized using conservative assumptions, including the use of the maximum open cell area to determine required sump storage volumes, and estimating required leachate storage volumes using stormwater routing techniques that provide conservative flow estimates and the rainfall from a 25- year, 24-hour storm event, as required by Chapter 401.2.D.4.a of the Rules. The internal leachate storage sumps are sized to handle the leachate volumes estimated by this technique with additional storage volume in the form of the "freeboard," consisting of the storage space above the maximum anticipated water level, designed into the sump.

BGS/NEWSME Exhibit 51 is the design model output for the Cell 12 internal leachate sump, as provided in Volume III Appendix D-6 of the application. This exhibit shows, through a comparison of the total runoff generated (i.e.,1.26 acre-ft or 54,900 cubic feet) versus the sump's total capacity at 154,000 cubic feet, that the amount of additional leachate storage capacity designed for the Cell 12 sump is nearly three times the volume needed to handle the leachate generated from a 25-year, 24-hour storm event occurring when the largest active operating area of the landfill is open and no active leachate pumping is occurring from the sump, such as from a power outage. [2]

Additionally, there is more leachate storage volume not included in this analysis from the void space of leachate collection sand and stone in the cell, and in the onsite leachate storage tank. The tank is sized with additional capacity as required by the Rules, Chapter 401.2.D.4.b.i, which requires the storage tank to include capacity equal to two feet of freeboard, or an additional 25 percent of the design capacity. Therefore, these two additional conditions provide further redundancy in the design of the leachate collection and handling system.

An example of the robustness of the Expansion's leachate storage capacity is the current landfill leachate system's ability to handle a 5.27 inch rain storm event that occurred on September 30, 2015. BGS/NEWSME Exhibit 52 is the leachate flow data from JRL during the month of September 2015. This data shows that, while the site-wide leachate flows increased from about 26,000 gallons per day on September 29,

[2] The Cell 12 sizing calculations for this sump were included in the application because it will have the largest active operating area of the six Expansion cells. The other landfill cell sumps will be sized in a similar manner, such that the entire system is designed to have more-than-adequate capacity for a 25-year, 24-hour storm.

2015, to about 112,000 gallons per day on September 30, 2015. The facility was able to safely accommodate these increased flows during this large storm event, without overflowing the internal leachate sumps, and simultaneously retaining significant reserve leachate storage capacity within the storage tank.[3]

Landfill Gas and Leachate Piping Design: Mr. Spencer expressed concern about the performance of the gas collector trenches (GCTs), as a result of the pipes collapsing, relative to the long term collection of landfill gas and the potential risk of fire or explosion, moisture buildup, and degradation rates for the waste (see Spencer Testimony at 6). Mr. Spencer raises a similar concern with respect to the collapsing of the leachate collection pipes.

First, the Expansion's GCTs are intended to function only for a limited time. As discussed in the application, "the GCTs will be constructed as an **interim method** of gas extraction until vertical extraction wells can be installed at final grades." (See Section 5.2 of Appendix I of Volume III of the application (emphasis added).) The vertical gas extraction wells are designed to collect and remove the landfill gas generated by the Expansion so that the horizontal trenches are not needed for long term gas collection. Thus, Mr. Spencer's concern about the long-term viability of the GCTs is misplaced.

Second, Mr. Spencer's concern about leachate pipes collapsing is addressed by the pipe design, which accounts for the overburden stresses to which these pipes will be subject. They are, therefore, designed not to collapse in this setting. The supporting design calculations are contained in Volume III, Appendix D-1 of the application.

Liner Leakage and Six Year Travel Time: Mr. Spencer commented on the six year travel time to sensitive receptors criterion defined by Chapter 401.1.C.1.c of the Rules, as follows:

> [I]t is as if we are planning for a leak. If the liner system is breached, it is difficult or impossible to fix it with all the waste in place. From the beginning of a leak it may take 6 years to get to drinking water sources, but once that leak starts it will

[3] As shown in Appendix D-8 of Volume III of the application, the leachate storage tank is about 24 feet high with a total storage capacity of 921,000 gallons. The peak leachate level in the tank was about 5.3 feet on the 30th.

> leak basically forever. So while JRL is called a "secure landfill," at the same time plans are in place that anticipate failure of the systems.

(Spencer Testimony at 6.)

Mr. Spencer is partially correct we are addressing the potential for liner leakage, but not for the reason that he suggests. Rather, the Rules require an applicant to demonstrate that the siting and design of the facility has been undertaken to meet the travel time standard. This standard essentially provides a "basis for design" for any landfill facility, and was used in the design of the Expansion as one of the criteria to establish the landfill layout and selection of the liner system. This standard, along with the contaminant transport standard (i.e., Chapter 401.1.C.1.d), were used during the design to quantify impacts in the event of hypothetical containment system failures. These analyses are due diligence exercises completed as part of the design process to assure a facility does not pose an unreasonable threat to any potential sensitive receptors,[4] as required by the Rules. We believe that using these analyses as part of the design process results in a design that is protective of the environment and surrounding sensitive receptors.

The analyses, and the assumptions used to complete the analyses, such as liner leakage rates, are not a quantification of "anticipated failure of the systems," as Mr. Spencer suggests. They are instead a prudent design evaluation tool used to quantify potential effects on the surrounding environment should an unanticipated failure of landfill containment systems occur. Completing these analyses and assigning values to parameters required to complete the analyses, such as liner leakage rates, does not mean that the composite double liner system proposed for this facility will leak, as suggested in Mr. Spencer's testimony. Rather these analyses are completed to demonstrate the adequacy of the design, and show that there is adequate time (i.e., at least six years) to respond to any unforeseen events that might possibly introduce leachate into the environment.

[4] As outlined in Volume II Section 7.1 of the Application, the sensitive receptors are conservatively identified as being the closest locations that could be offsite drinking water sources (e.g., they are located at the closest property boundaries). They are not actually current drinking water supplies.

In addition to these analyses, one of the primary reasons we completed an extensive evaluation of the site hydrogeology and the interconnectivity of the bedrock fracture systems at this site was to evaluate if a groundwater pumping system could collect leachate from below the developed site in the event of a breach of the liner system. This analysis confirmed that the site groundwater could be remediated if necessary by pumping groundwater from the bedrock. (See Volume II, Section 5.2.2 of the application.)

In his testimony, Mr. Spencer also referenced testimony (Exhibit Spencer 5) from an April10, 2008, landfill site assignment hearing before the Board of Health in Southbridge, Massachusetts, from David Bonnett, who was a consultant for Casella Waste on a project in that community. Mr. Spencer highlighted an excerpt from Mr. Bonnett's testimony that "all liners leak," which Mr. Spencer asserts is relevant to the Expansion, although he does not explain why. (See Spencer Testimony at 6.)

Without any further explanation, Mr. Spencer seems to be implying that a general statement about "all" landfill liners is applicable to the Expansion, and thus, that this particular landfill liner will inevitably leak. This type of generality cannot be applied to every specific case since landfill liner systems differ in composition, and are installed and operated under different conditions that influence the potential for liner leakage to occur. Therefore, I don't agree with Mr. Bonnett's statement.

In reviewing Mr. Bonnett's testimony (see Spencer Exhibit 5, p. 3), it appears that Mr. Bonnett's comments were addressing only the geomembrane portion of the liner system at that landfill, focusing on defects in the geomembranes from construction damage and environmental stress cracks. HDPE geomembranes may be susceptible to these issues. The Expansion design addresses both of these items, however.

First, the Expansion construction quality assurance program includes an electronic leak location survey, of the primary geomembrane liner after construction is completed. A practice only done on about two percent of the geomembranes installed. This survey detects construction damage to the geomembrane so any such damage is repaired prior to placement of waste in the cells.

Second, the susceptibility of HDPE geomembranes to environmental stress cracking is a function of the formulation of the materials used to make the geomembranes as well as the conditions under which the liner is installed. Both these items are addressed in the design of the Expansion through the specific product requirements for the geomembrane that will be used in the Expansion, and the configuration and installation requirements established for the liner system. For example, the project specifications require minimum environmental stress cracking resistance properties as defined by ASTM standards.

A meaningful discussion on the potential for the Expansion liner to leak must focus on the specific design, the conditions that need to be present for leakage to occur, and the many components that have been included in the landfill design to minimize the potential for liner leakage. For any liner to leak both a defect and a source of liquid need to be present in the location of the defect. The Expansion application contains a quantitative analysis of liner performance, which addresses these two factors, consisting of the modeling effort completed to estimate landfill leachate generation. This effort used the U.S. EPA's Hydraulic Evaluation of Landfill Performance (HELP) model. While this model is used to quantify leachate generation rates, as identified by Chapter 401.2.D.4.a.i of the Rules, it also provides information on the potential for liner leakage from a facility by modeling movement of liquids in the landfill. The HELP Model completed for the Expansion accounted for geomembrane defects, which apparently was the topic Mr. Bonnett was addressing. The model also accounts for the other properties and sequencing of the various liner components, and the physical conditions (i.e., impingement rates and liquid levels to which the liner will be subjected) that also influence the potential for liner leakage to occur, but were not addressed in Spencer's Exhibit 5. BGS/NEWSME Exhibit 53 provides the results of the HELP Model that were submitted in Volume III, Appendix C of the application. This modeling was completed assuming a total of four defects in the geomembrane components of the liner system. The modeling results demonstrate, through its quantification of the amount of liquid that may pass through the secondary liner (0.0 inches) that the Expansion liner system is designed to prevent liner leakage from occurring during the facility's operational and closure periods as a result of the items discussed. Therefore, Mr. Bonnett's statement is not applicable to this project.

Stormwater Management: On page 7 of his direct testimony, Mr. Spencer commented that "[t]he Public and environmental systems may be at risk from insufficient preparations for extreme precipitation events at JRL after an expansion and at present," citing a 2003 stormwater event that occurred at JRL, and extreme weather conditions that could occur at the site. Mr. Spencer also questioned the storm thresholds contained in the Rules, (see Spencer Testimony at 7), suggesting that "[t]here is a conflict because [the] rules only call for a 25-year flood threshold, and at the same time building to that lower standard will not adequately protect the environment and prevent harm to public welfare."

Mr. Spencer does not provide a quantitative basis for his statement, and appears to be suggesting that the 25-year, 24-hour design storm is a "lower standard" because a very localized short term rain event, with an intensity of about 8 inches in a few hours, occurred in Brownville, Maine a few years ago. Mr. Spencer states his opinion that "an event of this magnitude will surely happen at JRL," but does not substantiate his opinion with any analysis or data.

As an initial matter, use of the 25-year, 24-hour storm is the design storm required by Chapter 400.4.m of the Rules. The 25-year, 24-hour storm event is the common engineering standard used for stormwater analysis, and is used in other MEDEP contexts, such as the general stormwater rules in Chapter 500. The 25-year, 24-hour storm event has a 4% chance of occurring in any given year, meaning that in any given year there is a 96% chance that all storms will be smaller than this design storm. Mr. Spencer's suggestion that a storm like what occurred in Brownville "will surely happen at JRL" is not supported by an analysis of the storm by a National Weather Service meteorologist.

BGS/NEWSME Exhibit 54 contains a June 25, 2012 article from the Bangor Daily News on the Brownville storm in which Ken Wallingford, a meteorologist with the National Weather Service in Caribou, stated, "It's very rare that you have situations where things come together the way they did on Saturday." The National Weather Service analysis indicates that there is an extremely small probability of such an event occurring at JRL, or at any other location in the State. Therefore, it is not a basis to claim that the 25-year, 24-hour storm event is a "lower threshold."

What were not addressed in Mr. Spencer's testimony are the actual results of the stormwater analyses completed for the Expansion, which have been extensively reviewed by the MEDEP staff. While Mr. Spencer is correct that the stormwater retention ponds are sized based on a 25-year, 24-hour storm event, to comply with the Rules, the ponds also include structures that allow stormwater flow from **100-year** storm events to pass without impacting the integrity of the structures.

In fact, a September 30, 2015, storm event where 5.27 inches of rainfall fell, in Bangor, within a 24-hour period demonstrates the adequacy of the design storm criterion contained in the Rules for both the landfill containment system, and stormwater ponds. The onsite stormwater structures at JRL adequately handled this storm without affecting their integrity. This storm was larger than the largest recorded storm in 2003 of 2.89 inches, also recorded in Bangor, the year of a referenced event in Mr. Spencer's testimony, which occurred on September 28, 2003 (see BGS/NEWSME 55). Therefore, Mr. Spencer's assertion that the Expansion's stormwater design will neither adequately protect the environment, nor prevent harm to public welfare, is not supported by either the Expansion's design or the recent onsite performance of the landfill's stormwater and leachate collection systems during a large storm event.

II. MR. STEVE COGHLAN

Catastrophic Breach of the Containment Liner from Unprecedented Storm Events: Mr. Coghlan presents a rhetorical question concerning a catastrophic breach of the containment liner if there were an "unprecedented storm event" suggesting that BGS/NEWSME have been cavalier in drawing conclusions about lack of impacts (see Coghlan Testimony at 5). Yet he provides no data to support his contentions. This is in contrast to the information contained in the application, as referenced previously, and in my responses to Mr. Spencer's comments of a similar nature. The detailed evaluations completed using the criteria contained in the Rules demonstrates that the Expansion can be developed as proposed without impacting the surrounding environment.

Potential Impacts of the Expansion on Floodplains: Mr. Coghlan suggests in his testimony that using the current floodplain delineation completed in 1978 to assess the risk of flooding in 2020 and beyond is misleading and dangerous because it has not been adjusted for ACC (anthropogenic climate change) (Coghlan Testimony at 11). Mr. Coghlan then goes on to question the integrity of the containment structures, due to the horizontal distance between floodplain boundaries and the property boundary, and states: "I believe that failure to account for changing patterns in precipitation and encroachment of floodplain consistent with ACC renders these simulations overly optimistic and underestimates the risk of a catastrophic breaching or runoff event." (Coghlan Testimony at 11.) Mr. Coghlan provides no data to support his claim.

The use of the current floodplain delineation maps (completed in 1978) is what is required by Chapter 400.4.M.2.a. of the Rules. Mr. Coghlan' s assertions imply that assumed changes in weather patterns associated with ACC will result in damage to containment structures that are part of the Expansion. His basis appears to be the date that the floodplain mapping was completed, and the horizontal distance between the floodplain and property boundary. If we assume that Mr. Coghlan is correct about future weather patterns affecting floodplain boundaries, the potential risk these changes would have to containment structures would be more a function of the **vertical** elevation difference between the floodplain boundary and the landfill structures than the horizontal distance between them. If the current floodplain boundaries and containment structures are compared using topographic information, (see BGS/NEWSME 56) the boundary of the identified floodplains to the east are, at its highest elevation, around elevation 160, while the lowest proposed landfill base grades are at elevation 172, or a 12 foot difference. On the western side of the site, the floodplain boundary at its highest elevation is also around elevation 160, at its highest point, while the lowest landfill base grades are at 192, or a 32 foot difference. These elevation differences makes it highly improbable that any change in the floodplain boundaries as depicted on the current flood plain maps would affect the landfill containment structures.

In addition, Mr. Coghlan expressed concern with changes to design storm intensity in the future as addressed in the application (see Coghlan Testimony at 11). In addition to the discussion above addressing Mr. Spencer's comments, as outlined in Section 7.0 of Volume III of the application, detailed construction documents, including detailed engineering drawings, will be prepared prior to construction of any portion of the Expansion and submitted to MEDEP at least 6 months prior to the construction activity for review and approval. Any modifications to the design that may be needed due to the change in the design storm intensities would be made at that time. These changes would be minor in nature consisting of possible changes in culvert and ditch sizes and configurations.

Dated: 9/7/2016

Michael S. Booth, P.E.

STATE OF MAINE
Cumberland, ss.

Personally appeared before me the above-named Michael Booth and made oath that the foregoing is true and accurate to the best of his knowledge and belief.

Before me,

Dated: 9/7/16

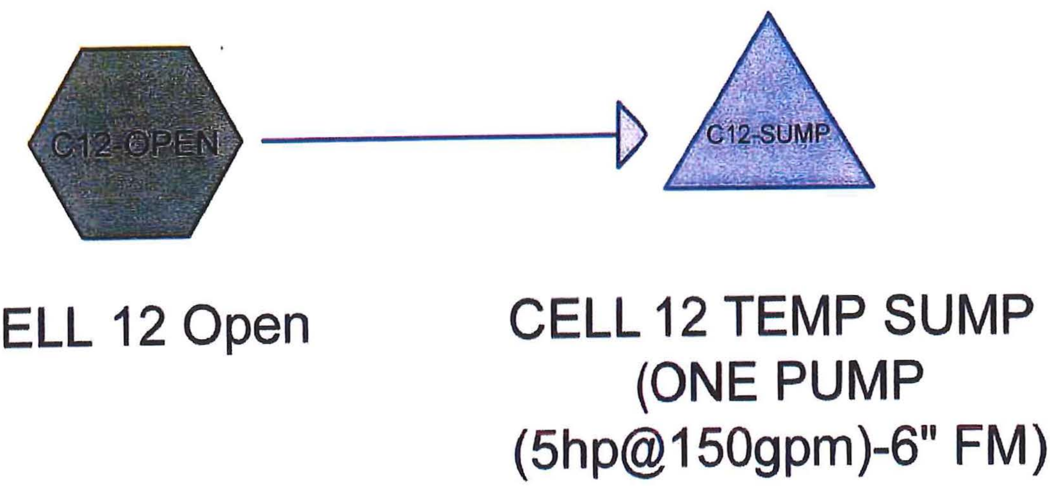
Holly A. Brooks
Notary Public
Name:
My Commission Expires:

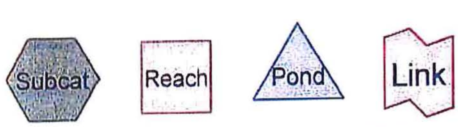
HOLLY A. BROOKS
Notary Public, Maine
My Commission Expires July 17, 2017

BGS/NEWSME EXHIBIT #51

APPLICATION VOLUME III
APPENDIX D-6
STORAGE VOLUME FOR CELL 12 LEACHATE SUMPS

CELL 12 SUMP & PUMP DESIGN





Routing Diagram for Sump-Design-Temporary
Prepared by Microsoft, Printed 5/5/2015
HydroCAD® 10.00 s/n 01260 © 2012 HydroCAD Software Solutions LLC

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
2.500	65	OPEN WASTE AT 38 PERCENT (C12-OPEN)
12.600	55	OPEN WASTE AT 5 PERCENT GRADE (C12-OPEN)
15.100	**57**	**TOTAL AREA**

Time span=0.00-60.00 hrs, dt=0.01 hrs, 6001 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentC12-OPEN: CELL 12 Open Runoff Area=15.100 ac 0.00% Impervious Runoff Depth=1.00"
Tc=15.0 min CN=57 Runoff=10.88 cfs 1.258 af

Pond C12-SUMP: CELL 12 TEMP SUMP Peak Elev=199.85' Storage=40,114 cf Inflow=10.88 cfs 1.258 af
Outflow=0.33 cfs 1.258 af

Total Runoff Area = 15.100 ac Runoff Volume = 1.258 af Average Runoff Depth = 1.00"
100.00% Pervious = 15.100 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment C12-OPEN: CELL 12 Open

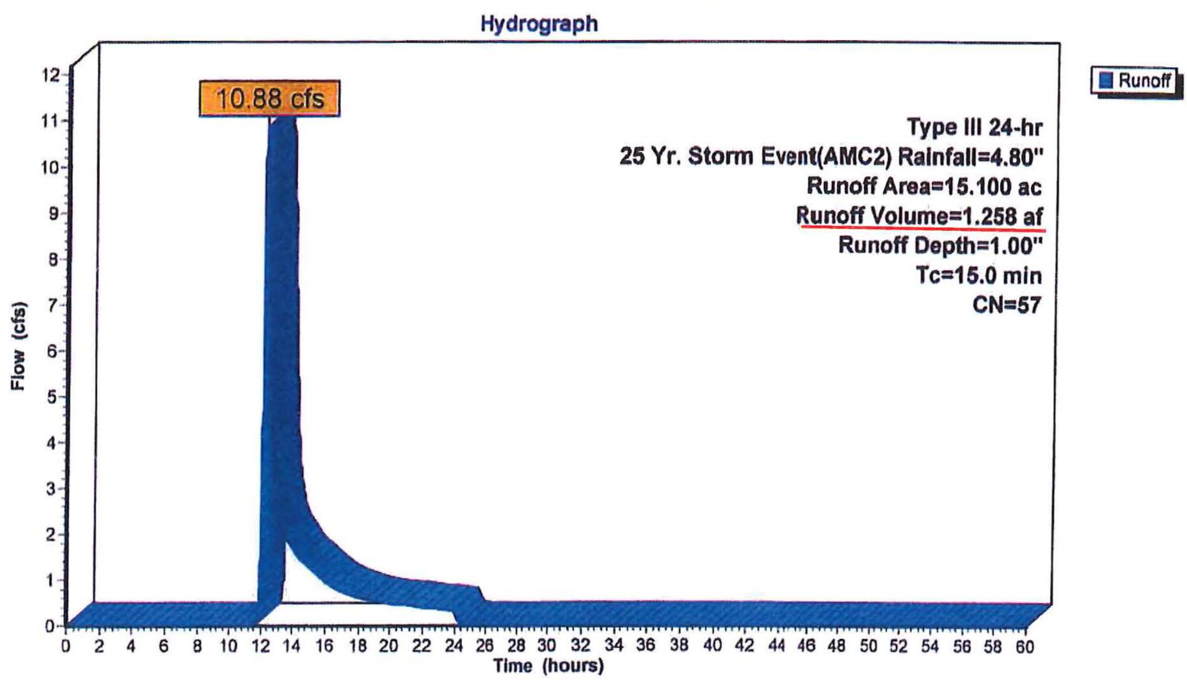
Runoff = 10.88 cfs @ 12.25 hrs, Volume= 1.258 af, Depth= 1.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 25 Yr. Storm Event(AMC2) Rainfall=4.80"

	Area (ac)	CN	Description
*	12.600	55	OPEN WASTE AT 5 PERCENT GRADE
*	2.500	65	OPEN WASTE AT 38 PERCENT
	15.100	57	Weighted Average
	15.100		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry, Time of Conc. (Conservative)**

Subcatchment C12-OPEN: CELL 12 Open



Summary for Pond C12-SUMP: CELL 12 TEMP SUMP (ONE PUMP (5hp@150gpm)-6" FM)

Inflow Area = 15.100 ac, 0.00% Impervious, Inflow Depth = 1.00" for 25 Yr. Storm Event(AMC2) event
Inflow = 10.88 cfs @ 12.25 hrs, Volume= 1.258 af
Outflow = 0.33 cfs @ 11.98 hrs, Volume= 1.258 af, Atten= 97%, Lag= 0.0 min
Primary = 0.33 cfs @ 11.98 hrs, Volume= 1.258 af

Routing by Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Peak Elev= 199.85' @ 23.99 hrs Surf.Area= 53,095 sf Storage= 40,114 cf
Flood Elev= 204.00' Surf.Area= 135,600 sf Storage= 154,250 cf

Plug-Flow detention time= 1,198.7 min calculated for 1.258 af (100% of inflow)
Center-of-Mass det. time= 1,198.9 min (2,096.1 - 897.3)

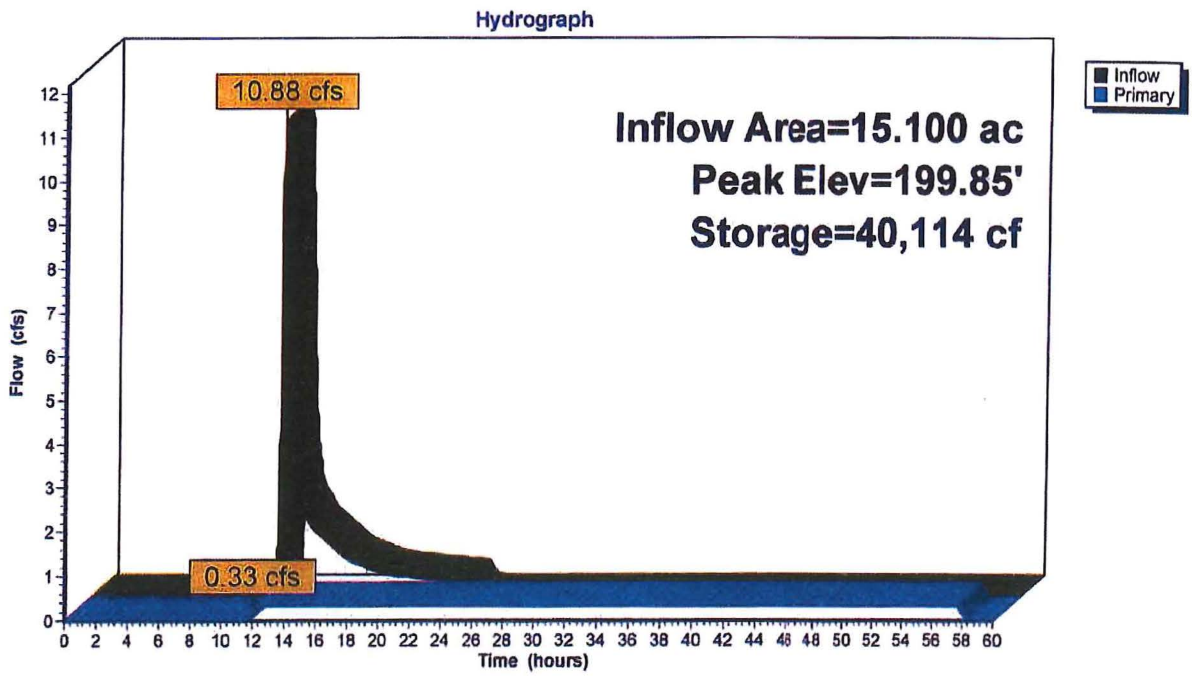
Volume	Invert	Avail.Storage	Storage Description
#1	193.00'	154,250 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
193.00	0	0.0	0	0
194.00	1,700	40.0	340	340
196.00	11,300	40.0	5,200	5,540
198.00	28,500	30.0	11,940	17,480
200.00	55,100	30.0	25,080	42,560
202.00	90,800	30.0	43,770	86,330
204.00	135,600	30.0	67,920	154,250

Device	Routing	Invert	Outlet Devices
#1	Primary	193.00'	**PUMP SYSTEM** Head (feet) 0.00 1.00 2.00 3.00 4.00 5.00 6.00 8.00 10.00 Disch. (cfs) 0.000 0.330 0.330 0.330 0.330 0.330 0.330 0.330 0.330

Primary OutFlow Max=0.33 cfs @ 11.98 hrs HW=194.04' (Free Discharge)
↑**1=PUMP SYSTEM** (Custom Controls 0.33 cfs)

Pond C12-SUMP: CELL 12 TEMP SUMP (ONE PUMP (5hp@150gpm)-6" FM)



Hydrograph for Pond C12-SUMP: CELL 12 TEMP SUMP (ONE PUMP (5hp@150gpm)-6" FM)

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Primary (cfs)
0.00	0.00	0	193.00	0.00
0.20	0.00	0	193.00	0.00
0.40	0.00	0	193.00	0.00
0.60	0.00	0	193.00	0.00
0.80	0.00	0	193.00	0.00
1.00	0.00	0	193.00	0.00
1.20	0.00	0	193.00	0.00
1.40	0.00	0	193.00	0.00
1.60	0.00	0	193.00	0.00
1.80	0.00	0	193.00	0.00
2.00	0.00	0	193.00	0.00
2.20	0.00	0	193.00	0.00
2.40	0.00	0	193.00	0.00
2.60	0.00	0	193.00	0.00
2.80	0.00	0	193.00	0.00
3.00	0.00	0	193.00	0.00
3.20	0.00	0	193.00	0.00
3.40	0.00	0	193.00	0.00
3.60	0.00	0	193.00	0.00
3.80	0.00	0	193.00	0.00
4.00	0.00	0	193.00	0.00
4.20	0.00	0	193.00	0.00
4.40	0.00	0	193.00	0.00
4.60	0.00	0	193.00	0.00
4.80	0.00	0	193.00	0.00
5.00	0.00	0	193.00	0.00
5.20	0.00	0	193.00	0.00
5.40	0.00	0	193.00	0.00
5.60	0.00	0	193.00	0.00
5.80	0.00	0	193.00	0.00
6.00	0.00	0	193.00	0.00
6.20	0.00	0	193.00	0.00
6.40	0.00	0	193.00	0.00
6.60	0.00	0	193.00	0.00
6.80	0.00	0	193.00	0.00
7.00	0.00	0	193.00	0.00
7.20	0.00	0	193.00	0.00
7.40	0.00	0	193.00	0.00
7.60	0.00	0	193.00	0.00
7.80	0.00	0	193.00	0.00
8.00	0.00	0	193.00	0.00
8.20	0.00	0	193.00	0.00
8.40	0.00	0	193.00	0.00
8.60	0.00	0	193.00	0.00
8.80	0.00	0	193.00	0.00
9.00	0.00	0	193.00	0.00
9.20	0.00	0	193.00	0.00
9.40	0.00	0	193.00	0.00
9.60	0.00	0	193.00	0.00
9.80	0.00	0	193.00	0.00
10.00	0.00	0	193.00	0.00
10.20	0.00	0	193.00	0.00
10.40	0.00	0	193.00	0.00

Hydrograph for Pond C12-SUMP: CELL 12 TEMP SUMP (ONE PUMP (5hp@150gpm)-6" FM) (continued)

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Primary (cfs)
10.60	0.00	0	193.00	0.00
10.80	0.00	0	193.00	0.00
11.00	0.00	0	193.00	0.00
11.20	0.00	0	193.00	0.00
11.40	0.00	0	193.00	0.00
11.60	0.00	0	193.00	0.00
11.80	0.16	12	193.18	**0.06**
12.00	2.02	477	194.16	**0.33**
12.20	**10.41**	4,575	195.78	0.33
12.40	**8.95**	11,671	197.23	0.33
12.60	5.72	16,772	197.92	0.33
12.80	3.37	19,652	198.24	0.33
13.00	2.62	21,535	198.43	0.33
13.20	2.18	23,016	198.57	0.33
13.40	2.00	24,275	198.68	0.33
13.60	1.88	25,435	198.79	0.33
13.80	1.77	26,516	198.88	0.33
14.00	1.66	27,514	198.96	0.33
14.20	1.54	28,427	199.03	0.33
14.40	1.47	29,272	199.10	0.33
14.60	1.41	30,073	199.16	0.33
14.80	1.35	30,833	199.22	0.33
15.00	1.29	31,549	199.27	0.33
15.20	1.23	32,222	199.32	0.33
15.40	1.17	32,848	199.36	0.33
15.60	1.10	33,427	199.40	0.33
15.80	1.03	33,957	199.44	0.33
16.00	0.96	34,437	199.48	0.33
16.20	0.89	34,867	199.50	0.33
16.40	0.86	35,259	199.53	0.33
16.60	0.82	35,626	199.56	0.33
16.80	0.79	35,971	199.58	0.33
17.00	0.76	36,294	199.60	0.33
17.20	0.73	36,595	199.62	0.33
17.40	0.70	36,873	199.64	0.33
17.60	0.67	37,129	199.66	0.33
17.80	0.64	37,361	199.67	0.33
18.00	0.60	37,569	199.69	0.33
18.20	0.57	37,754	199.70	0.33
18.40	0.56	37,923	199.71	0.33
18.60	0.55	38,084	199.72	0.33
18.80	0.54	38,238	199.73	0.33
19.00	0.53	38,385	199.74	0.33
19.20	0.52	38,525	199.75	0.33
19.40	0.51	38,659	199.76	0.33
19.60	0.50	38,787	199.76	0.33
19.80	0.49	38,907	199.77	0.33
20.00	0.48	39,020	199.78	0.33
20.20	0.47	39,127	199.79	0.33
20.40	0.47	39,227	199.79	0.33
20.60	0.46	39,322	199.80	0.33
20.80	0.45	39,412	199.80	0.33
21.00	0.44	39,497	199.81	0.33

Hydrograph for Pond C12-SUMP: CELL 12 TEMP SUMP (ONE PUMP (5hp@150gpm)-6" FM) (continued)

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Primary (cfs)
21.20	0.44	39,576	199.82	0.33
21.40	0.43	39,650	199.82	0.33
21.60	0.42	39,719	199.82	0.33
21.80	0.41	39,783	199.83	0.33
22.00	0.41	39,841	199.83	0.33
22.20	0.40	39,894	199.84	0.33
22.40	0.39	39,941	199.84	0.33
22.60	0.38	39,983	199.84	0.33
22.80	0.38	40,019	199.84	0.33
23.00	0.37	40,049	199.84	0.33
23.20	0.36	40,075	199.85	0.33
23.40	0.35	40,094	199.85	0.33
23.60	0.35	40,108	199.85	0.33
23.80	0.34	**40,116**	**199.85**	0.33
24.00	0.33	**40,118**	**199.85**	0.33
24.20	0.18	40,086	199.85	0.33
24.40	0.03	39,906	199.84	0.33
24.60	0.00	39,677	199.82	0.33
24.80	0.00	39,440	199.81	0.33
25.00	0.00	39,202	199.79	0.33
25.20	0.00	38,965	199.78	0.33
25.40	0.00	38,727	199.76	0.33
25.60	0.00	38,489	199.75	0.33
25.80	0.00	38,252	199.73	0.33
26.00	0.00	38,014	199.72	0.33
26.20	0.00	37,777	199.70	0.33
26.40	0.00	37,539	199.68	0.33
26.60	0.00	37,301	199.67	0.33
26.80	0.00	37,064	199.65	0.33
27.00	0.00	36,826	199.64	0.33
27.20	0.00	36,589	199.62	0.33
27.40	0.00	36,351	199.61	0.33
27.60	0.00	36,113	199.59	0.33
27.80	0.00	35,876	199.57	0.33
28.00	0.00	35,638	199.56	0.33
28.20	0.00	35,401	199.54	0.33
28.40	0.00	35,163	199.52	0.33
28.60	0.00	34,925	199.51	0.33
28.80	0.00	34,688	199.49	0.33
29.00	0.00	34,450	199.48	0.33
29.20	0.00	34,213	199.46	0.33
29.40	0.00	33,975	199.44	0.33
29.60	0.00	33,737	199.43	0.33
29.80	0.00	33,500	199.41	0.33
30.00	0.00	33,262	199.39	0.33
30.20	0.00	33,025	199.38	0.33
30.40	0.00	32,787	199.36	0.33
30.60	0.00	32,549	199.34	0.33
30.80	0.00	32,312	199.32	0.33
31.00	0.00	32,074	199.31	0.33
31.20	0.00	31,837	199.29	0.33
31.40	0.00	31,599	199.27	0.33
31.60	0.00	31,361	199.26	0.33

Hydrograph for Pond C12-SUMP: CELL 12 TEMP SUMP (ONE PUMP (5hp@150gpm)-6" FM) (continued)

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Primary (cfs)
31.80	0.00	31,124	199.24	0.33
32.00	0.00	30,886	199.22	0.33
32.20	0.00	30,649	199.20	0.33
32.40	0.00	30,411	199.18	0.33
32.60	0.00	30,173	199.17	0.33
32.80	0.00	29,936	199.15	0.33
33.00	0.00	29,698	199.13	0.33
33.20	0.00	29,461	199.11	0.33
33.40	0.00	29,223	199.09	0.33
33.60	0.00	28,985	199.08	0.33
33.80	0.00	28,748	199.06	0.33
34.00	0.00	28,510	199.04	0.33
34.20	0.00	28,273	199.02	0.33
34.40	0.00	28,035	199.00	0.33
34.60	0.00	27,797	198.98	0.33
34.80	0.00	27,560	198.96	0.33
35.00	0.00	27,322	198.94	0.33
35.20	0.00	27,085	198.92	0.33
35.40	0.00	26,847	198.90	0.33
35.60	0.00	26,609	198.88	0.33
35.80	0.00	26,372	198.86	0.33
36.00	0.00	26,134	198.85	0.33
36.20	0.00	25,897	198.83	0.33
36.40	0.00	25,659	198.80	0.33
36.60	0.00	25,421	198.78	0.33
36.80	0.00	25,184	198.76	0.33
37.00	0.00	24,946	198.74	0.33
37.20	0.00	24,709	198.72	0.33
37.40	0.00	24,471	198.70	0.33
37.60	0.00	24,233	198.68	0.33
37.80	0.00	23,996	198.66	0.33
38.00	0.00	23,758	198.64	0.33
38.20	0.00	23,521	198.62	0.33
38.40	0.00	23,283	198.60	0.33
38.60	0.00	23,045	198.57	0.33
38.80	0.00	22,808	198.55	0.33
39.00	0.00	22,570	198.53	0.33
39.20	0.00	22,333	198.51	0.33
39.40	0.00	22,095	198.48	0.33
39.60	0.00	21,857	198.46	0.33
39.80	0.00	21,620	198.44	0.33
40.00	0.00	21,382	198.42	0.33
40.20	0.00	21,145	198.39	0.33
40.40	0.00	20,907	198.37	0.33
40.60	0.00	20,669	198.34	0.33
40.80	0.00	20,432	198.32	0.33
41.00	0.00	20,194	198.30	0.33
41.20	0.00	19,957	198.27	0.33
41.40	0.00	19,719	198.25	0.33
41.60	0.00	19,481	198.22	0.33
41.80	0.00	19,244	198.20	0.33
42.00	0.00	19,006	198.17	0.33
42.20	0.00	18,769	198.15	0.33

Hydrograph for Pond C12-SUMP: CELL 12 TEMP SUMP (ONE PUMP (5hp@150gpm)-6" FM) (continued)

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Primary (cfs)
42.40	0.00	18,531	198.12	0.33
42.60	0.00	18,293	198.09	0.33
42.80	0.00	18,056	198.07	0.33
43.00	0.00	17,818	198.04	0.33
43.20	0.00	17,581	198.01	0.33
43.40	0.00	17,343	197.98	0.33
43.60	0.00	17,105	197.96	0.33
43.80	0.00	16,868	197.93	0.33
44.00	0.00	16,630	197.90	0.33
44.20	0.00	16,393	197.87	0.33
44.40	0.00	16,155	197.84	0.33
44.60	0.00	15,917	197.81	0.33
44.80	0.00	15,680	197.78	0.33
45.00	0.00	15,442	197.75	0.33
45.20	0.00	15,205	197.72	0.33
45.40	0.00	14,967	197.69	0.33
45.60	0.00	14,729	197.66	0.33
45.80	0.00	14,492	197.63	0.33
46.00	0.00	14,254	197.60	0.33
46.20	0.00	14,017	197.57	0.33
46.40	0.00	13,779	197.53	0.33
46.60	0.00	13,541	197.50	0.33
46.80	0.00	13,304	197.47	0.33
47.00	0.00	13,066	197.44	0.33
47.20	0.00	12,829	197.40	0.33
47.40	0.00	12,591	197.37	0.33
47.60	0.00	12,353	197.33	0.33
47.80	0.00	12,116	197.30	0.33
48.00	0.00	11,878	197.26	0.33
48.20	0.00	11,641	197.23	0.33
48.40	0.00	11,403	197.19	0.33
48.60	0.00	11,165	197.15	0.33
48.80	0.00	10,928	197.12	0.33
49.00	0.00	10,690	197.08	0.33
49.20	0.00	10,453	197.04	0.33
49.40	0.00	10,215	197.00	0.33
49.60	0.00	9,977	196.96	0.33
49.80	0.00	9,740	196.92	0.33
50.00	0.00	9,502	196.88	0.33
50.20	0.00	9,265	196.83	0.33
50.40	0.00	9,027	196.79	0.33
50.60	0.00	8,789	196.75	0.33
50.80	0.00	8,552	196.70	0.33
51.00	0.00	8,314	196.65	0.33
51.20	0.00	8,077	196.61	0.33
51.40	0.00	7,839	196.56	0.33
51.60	0.00	7,601	196.51	0.33
51.80	0.00	7,364	196.46	0.33
52.00	0.00	7,126	196.41	0.33
52.20	0.00	6,889	196.35	0.33
52.40	0.00	6,651	196.29	0.33
52.60	0.00	6,413	196.24	0.33
52.80	0.00	6,176	196.18	0.33

Hydrograph for Pond C12-SUMP: CELL 12 TEMP SUMP (ONE PUMP (5hp@150gpm)-6" FM) (continued)

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Primary (cfs)
53.00	0.00	5,938	196.11	0.33
53.20	0.00	5,701	196.05	0.33
53.40	0.00	5,463	195.98	0.33
53.60	0.00	5,225	195.93	0.33
53.80	0.00	4,988	195.87	0.33
54.00	0.00	4,750	195.82	0.33
54.20	0.00	4,513	195.76	0.33
54.40	0.00	4,275	195.70	0.33
54.60	0.00	4,037	195.64	0.33
54.80	0.00	3,800	195.58	0.33
55.00	0.00	3,562	195.51	0.33
55.20	0.00	3,325	195.44	0.33
55.40	0.00	3,087	195.37	0.33
55.60	0.00	2,849	195.30	0.33
55.80	0.00	2,612	195.22	0.33
56.00	0.00	2,374	195.14	0.33
56.20	0.00	2,137	195.06	0.33
56.40	0.00	1,899	194.97	0.33
56.60	0.00	1,661	194.87	0.33
56.80	0.00	1,424	194.77	0.33
57.00	0.00	1,186	194.65	0.33
57.20	0.00	949	194.52	0.33
57.40	0.00	711	194.36	0.33
57.60	0.00	473	194.16	0.33
57.80	0.00	244	193.85	0.28
58.00	0.00	84	193.50	0.16
58.20	0.00	8	193.15	0.05
58.40	0.00	0	193.00	0.00
58.60	0.00	0	193.00	0.00
58.80	0.00	0	193.00	0.00
59.00	0.00	0	193.00	0.00
59.20	0.00	0	193.00	0.00
59.40	0.00	0	193.00	0.00
59.60	0.00	0	193.00	0.00
59.80	0.00	0	193.00	0.00
60.00	0.00	0	193.00	0.00

BGS/NEWSME 52

BGS/NEWSME EXHIBIT #52

SEPTEMBER 2015 LEACHATE FLOW

DATA FROM JRL

LEACHATE GENERATIONS RECORDS JUNIPER RIDGE LANDFILL SEPTEMBER 2015

Date	Landfill Data								
	LF UD Cond. (uS/cm)	Pond UD Flow (Gal)	Pond LD Flow (Gal)	Pond UD Cond(uS/cm)	Cell 4 Flow (Gal)	Cell 5 Flow (Gal)	Cell 8 Flow (Gal)	Tank Level (Ft)	Generator Runtime (Min)
09/01/15	439	0	0	459	11,305	7,075	1,335	4.27	0
09/02/15	438	0	0	462	13,540	8,290	340	4.18	0
09/03/15	436	0	0	464	13,405	5,375	1,540	3.44	0
09/04/15	433	0	0	463	11,205	5,895	1,415	3.02	0
09/05/15	435	0	0	462	11,125	8,650	405	3.67	0
09/06/15	438	0	0	463	12,990	6,580	445	4.28	0
09/07/15	438	0	0	465	12,920	8,920	975	5.04	0
09/08/15	435	0	0	468	11,075	5,830	1,965	4.55	0
09/09/15	436	0	0	468	12,810	7,490	505	3.66	0
09/10/15	435	0	0	470	12,800	7,360	1,805	3.23	0
09/11/15	425	0	0	470	18,925	10,210	505	3.05	0
09/12/15	426	0	0	468	12,640	14,655	1,630	3.91	0
09/13/15	433	0	0	465	12,500	10,065	1,055	4.65	0
09/14/15	412	0	0	461	19,780	15,285	1,395	5.14	0
09/15/15	430	0	0	461	11,725	14,280	705	4.64	0
09/16/15	444	0	0	459	12,625	6,775	765	4.42	0
09/17/15	451	0	0	465	12,525	10,215	160	3.86	0
09/18/15	453	0	0	468	12,430	11,645	0	3.75	0
09/19/15	449	0	0	469	12,345	10,940	1,690	4.47	0
09/20/15	444	0	0	470	12,565	10,480	2,720	5.19	0
09/21/15	441	0	0	466	19,455	3,875	1,290	5.04	0
09/22/15	443	0	0	466	16,295	4,785	545	4.45	0
09/23/15	447	0	0	471	13,965	7,040	0	4.22	0
09/24/15	446	0	0	472	11,785	6,435	0	3.73	0
09/25/15	444	0	0	472	10,135	6,185	0	3.19	0
09/26/15	445	0	0	469	10,210	6,790	235	3.71	0
09/27/15	449	0	0	469	12,370	6,520	0	4.24	0
09/28/15	451	0	0	475	10,520	6,375	0	3.23	0
09/29/15	450	0	0	474	12,490	10,525	2,740	2.59	0
09/30/15	230	0	0	477	43,155	64,405	4,120	5.35	0
	0	0	0	0	0	0	0	0.00	0
Total		**0**	**0**		421,615	308950	30285		0

BGS/NEWSME 53

BGS/NEWSME EXHIBIT #53

APPLICATION VOLUME III
APPENDIX C
HELP MODEL OUTPUT DATA

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\HELP3\jrl\expan\DATA4.D4
TEMPERATURE DATA FILE:      C:\HELP3\jrl\expan\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\jrl\expan\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\jrl\expan\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\jrl\expan\90W-FSC.D10
OUTPUT DATA FILE:           C:\HELP3\jrl\expan\90W-FSC.OUT


TIME:  10:28     DATE:  12/19/2014


******************************************************************************

     TITLE:  CASELLA - JUNIPER RIDGE EXPANSION - FINAL COVER (RUNOFF)

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                   LAYER  1
                                   --------

                        TYPE 1 - VERTICAL PERCOLATION LAYER
                            MATERIAL TEXTURE NUMBER  12
           THICKNESS                   =     12.00   INCHES
           POROSITY                    =      0.4710 VOL/VOL
           FIELD CAPACITY              =      0.3420 VOL/VOL
           WILTING POINT               =      0.2100 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.3597 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.419999997000E-04 CM/SEC
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 2

```
THICKNESS                    =      12.00    INCHES
POROSITY                     =       0.4370 VOL/VOL
FIELD CAPACITY               =       0.0620 VOL/VOL
WILTING POINT                =       0.0240 VOL/VOL
INITIAL SOIL WATER CONTENT   =       0.1187 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.579999993000E-02 CM/SEC
```

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

```
THICKNESS                    =       0.20    INCHES
POROSITY                     =       0.8500 VOL/VOL
FIELD CAPACITY               =       0.0100 VOL/VOL
WILTING POINT                =       0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT   =       0.0117 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =   10.0000000000       CM/SEC
SLOPE                        =       5.00    PERCENT
DRAINAGE LENGTH              =     150.0     FEET
```

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

```
THICKNESS                    =       0.04    INCHES
POROSITY                     =       0.0000 VOL/VOL
FIELD CAPACITY               =       0.0000 VOL/VOL
WILTING POINT                =       0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT   =       0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY          =       1.00    HOLES/ACRE
FML INSTALLATION DEFECTS     =       3.00    HOLES/ACRE
FML PLACEMENT QUALITY        =  3 - GOOD
```

LAYER 5

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16

```
THICKNESS                    =      18.00    INCHES
```

```
POROSITY                    =      0.4270 VOL/VOL
FIELD CAPACITY              =      0.4180 VOL/VOL
WILTING POINT               =      0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.4270 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000001000E-06 CM/SEC


                        LAYER  6
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   2
THICKNESS                   =      6.00   INCHES
POROSITY                    =      0.4370 VOL/VOL
FIELD CAPACITY              =      0.0620 VOL/VOL
WILTING POINT               =      0.0240 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0620 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.579999993000E-02 CM/SEC


                        LAYER  7
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  18
THICKNESS                   =   1080.00   INCHES
POROSITY                    =      0.6710 VOL/VOL
FIELD CAPACITY              =      0.2920 VOL/VOL
WILTING POINT               =      0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                        LAYER  8
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   1
THICKNESS                   =     12.00   INCHES
POROSITY                    =      0.4170 VOL/VOL
FIELD CAPACITY              =      0.0450 VOL/VOL
WILTING POINT               =      0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.999999978000E-02 CM/SEC


                        LAYER  9
                        --------
```

```
              TYPE 2 - LATERAL DRAINAGE LAYER
                MATERIAL TEXTURE NUMBER  34
THICKNESS                      =       0.25    INCHES
POROSITY                       =       0.8500 VOL/VOL
FIELD CAPACITY                 =       0.0100 VOL/VOL
WILTING POINT                  =       0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT     =       0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND.      =    33.0000000000      CM/SEC
SLOPE                          =       3.00    PERCENT
DRAINAGE LENGTH                =     220.0     FEET


                            LAYER 10
                            --------

              TYPE 4 - FLEXIBLE MEMBRANE LINER
                MATERIAL TEXTURE NUMBER  35
THICKNESS                      =       0.08    INCHES
POROSITY                       =       0.0000 VOL/VOL
FIELD CAPACITY                 =       0.0000 VOL/VOL
WILTING POINT                  =       0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT     =       0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.      =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY            =       1.00    HOLES/ACRE
FML INSTALLATION DEFECTS       =       3.00    HOLES/ACRE
FML PLACEMENT QUALITY          =  3 - GOOD


                            LAYER 11
                            --------

                TYPE 3 - BARRIER SOIL LINER
                MATERIAL TEXTURE NUMBER   0
THICKNESS                      =       0.24    INCHES
POROSITY                       =       0.7500 VOL/VOL
FIELD CAPACITY                 =       0.7470 VOL/VOL
WILTING POINT                  =       0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT     =       0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.      =  0.499999997000E-08 CM/SEC


                            LAYER 12
                            --------

             TYPE 1 - VERTICAL PERCOLATION LAYER
                MATERIAL TEXTURE NUMBER   0
THICKNESS                      =      12.00    INCHES
POROSITY                       =       0.4100 VOL/VOL
FIELD CAPACITY                 =       0.3900 VOL/VOL
WILTING POINT                  =       0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT     =       0.3900 VOL/VOL
```

```
EFFECTIVE SAT. HYD. COND.   =  0.100000001000E-06 CM/SEC


                        LAYER 13
                        --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   1
THICKNESS                   =     12.00    INCHES
POROSITY                    =      0.4170 VOL/VOL
FIELD CAPACITY              =      0.0450 VOL/VOL
WILTING POINT               =      0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.999999978000E-02 CM/SEC


                        LAYER 14
                        --------

                TYPE 2 - LATERAL DRAINAGE LAYER
                  MATERIAL TEXTURE NUMBER  20
THICKNESS                   =      0.20    INCHES
POROSITY                    =      0.8500 VOL/VOL
FIELD CAPACITY              =      0.0100 VOL/VOL
WILTING POINT               =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =   10.0000000000      CM/SEC
SLOPE                       =      3.00    PERCENT
DRAINAGE LENGTH             =    400.0     FEET


                        LAYER 15
                        --------

                TYPE 4 - FLEXIBLE MEMBRANE LINER
                  MATERIAL TEXTURE NUMBER  35
THICKNESS                   =      0.06    INCHES
POROSITY                    =      0.0000 VOL/VOL
FIELD CAPACITY              =      0.0000 VOL/VOL
WILTING POINT               =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY         =      1.00    HOLES/ACRE
FML INSTALLATION DEFECTS    =      3.00    HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD


                        LAYER 16
                        --------
```

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

```
THICKNESS                  =     12.00   INCHES
POROSITY                   =      0.4100 VOL/VOL
FIELD CAPACITY             =      0.3900 VOL/VOL
WILTING POINT              =      0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.3898 VOL/VOL
EFFECTIVE SAT. HYD. COND.  = 0.100000001000E-06 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-SPECIFIED CURVE NUMBER OF 79.0, A SURFACE SLOPE OF 5.% AND A SLOPE LENGTH OF 200. FEET.

```
SCS RUNOFF CURVE NUMBER            =     80.20
FRACTION OF AREA ALLOWING RUNOFF   =    100.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE =      1.000  ACRES
EVAPORATIVE ZONE DEPTH             =      8.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE  =      2.949  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE =      3.768  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE =      1.680  INCHES
INITIAL SNOW WATER                 =      1.682  INCHES
INITIAL WATER IN LAYER MATERIALS   =    339.783  INCHES
TOTAL INITIAL WATER                =    341.465  INCHES
TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
BANGOR MAINE

```
STATION LATITUDE                      = 44.80 DEGREES
MAXIMUM LEAF AREA INDEX               =  0.00
START OF GROWING SEASON (JULIAN DATE) =   134
END OF GROWING SEASON (JULIAN DATE)   =   263
EVAPORATIVE ZONE DEPTH                =  8.0  INCHES
AVERAGE ANNUAL WIND SPEED             =  8.70 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 70.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 72.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 77.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 76.00 %
```

NOTE: PRECIPITATION DATA FOR ORONO ME US ORONO ME US
WAS ENTERED BY THE USER.

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR BANGOR MAINE

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
23.60	16.40	27.90	43.90	53.40	57.60
66.90	72.80	55.70	37.50	31.10	8.90

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR BANGOR MAINE
AND STATION LATITUDE = 44.80 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1980 THROUGH 2014

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	2.88	2.82	3.19	3.29	3.81	2.96
	3.72	3.41	3.93	3.97	4.09	2.86
STD. DEVIATIONS	1.25	1.29	1.68	1.51	1.81	1.97
	1.79	1.50	2.04	1.72	2.12	1.52
RUNOFF						
TOTALS	0.879	0.134	5.335	5.740	0.144	0.270
	0.234	0.386	0.434	0.208	0.887	0.001
STD. DEVIATIONS	1.065	0.321	3.679	5.213	0.280	0.771
	0.348	0.622	0.946	0.321	1.023	0.005
EVAPOTRANSPIRATION						
TOTALS	0.543	0.390	0.520	1.686	3.023	2.409
	2.794	2.509	2.057	1.289	0.606	0.290
STD. DEVIATIONS	0.080	0.065	0.105	0.664	0.981	1.130
	1.134	0.919	0.623	0.280	0.225	0.050
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.1057	0.0539	0.0410	0.3567	0.9113	0.5695
	0.4680	0.5947	0.8362	1.7279	1.8491	0.5237
STD. DEVIATIONS	0.0335	0.0114	0.0067	0.5192	0.6316	0.5074
	0.4388	0.5931	0.8018	1.3543	1.3987	0.5085
PERCOLATION/LEAKAGE THROUGH LAYER 5						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LATERAL DRAINAGE COLLECTED FROM LAYER 9						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 11

```
    -------------------------------------
      TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                             0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

      STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                             0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    LATERAL DRAINAGE COLLECTED FROM LAYER 14
    ----------------------------------------
      TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                             0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

      STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                             0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    PERCOLATION/LEAKAGE THROUGH LAYER 15
    ------------------------------------
      TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                             0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

      STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                             0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    PERCOLATION/LEAKAGE THROUGH LAYER 16
    ------------------------------------
      TOTALS                 0.0001   0.0001   0.0001   0.0001   0.0001   0.0001
                             0.0001   0.0001   0.0001   0.0001   0.0001   0.0001

      STD. DEVIATIONS        0.0001   0.0001   0.0001   0.0001   0.0001   0.0001
                             0.0001   0.0001   0.0001   0.0001   0.0001   0.0001


  -------------------------------------------------------------------------------
                 AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
  -------------------------------------------------------------------------------


    DAILY AVERAGE HEAD ON TOP OF LAYER  4
    -------------------------------------
      AVERAGES               0.0002   0.0001   0.0001   0.0006   0.0016   0.0010
                             0.0008   0.0010   0.0015   0.0030   0.0033   0.0009

      STD. DEVIATIONS        0.0001   0.0000   0.0000   0.0009   0.0011   0.0009
                             0.0008   0.0010   0.0014   0.0023   0.0025   0.0009

    DAILY AVERAGE HEAD ON TOP OF LAYER 10
    -------------------------------------
      AVERAGES               0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                             0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

      STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                             0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    DAILY AVERAGE HEAD ON TOP OF LAYER 15
    -------------------------------------
      AVERAGES               0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                             0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
```

STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

****
****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1980 THROUGH 2014

	INCHES	CU. FEET	PERCENT
PRECIPITATION	40.94 (9.088)	148595.7	100.00
RUNOFF	14.653 (5.6930)	53188.82	35.794
EVAPOTRANSPIRATION	18.116 (2.7902)	65760.21	44.254
LATERAL DRAINAGE COLLECTED FROM LAYER 3	8.03750 (3.40386)	29176.137	19.63458
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00000 (0.00000)	0.014	0.00001
AVERAGE HEAD ON TOP OF LAYER 4	0.001 (0.000)		
LATERAL DRAINAGE COLLECTED FROM LAYER 9	0.00000 (0.00000)	0.014	0.00001
PERCOLATION/LEAKAGE THROUGH LAYER 11	0.00000 (0.00000)	0.001	0.00000
AVERAGE HEAD ON TOP OF LAYER 10	0.000 (0.000)		
LATERAL DRAINAGE COLLECTED FROM LAYER 14	0.00000 (0.00000)	0.000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 15	0.00000 (0.00000)	0.001	0.00000
AVERAGE HEAD ON TOP OF LAYER 15	0.000 (0.000)		
PERCOLATION/LEAKAGE THROUGH LAYER 16	0.00168 (0.00078)	6.095	0.00410
CHANGE IN WATER STORAGE	0.128 (4.3480)	464.41	0.313

****
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PEAK DAILY VALUES FOR YEARS 1980 THROUGH 2014

	(INCHES)	(CU. FT.)
PRECIPITATION	4.80	17424.000
RUNOFF	6.938	25183.8262
DRAINAGE COLLECTED FROM LAYER 3	0.90808	3296.34058
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00052
AVERAGE HEAD ON TOP OF LAYER 4	0.048	
MAXIMUM HEAD ON TOP OF LAYER 4	0.095	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	1.3 FEET	
DRAINAGE COLLECTED FROM LAYER 9	0.00000	0.00042
PERCOLATION/LEAKAGE THROUGH LAYER 11	0.000000	0.00001
AVERAGE HEAD ON TOP OF LAYER 10	0.000	
MAXIMUM HEAD ON TOP OF LAYER 10	0.005	
LOCATION OF MAXIMUM HEAD IN LAYER 9 (DISTANCE FROM DRAIN)	0.0 FEET	
DRAINAGE COLLECTED FROM LAYER 14	0.00000	0.00001
PERCOLATION/LEAKAGE THROUGH LAYER 15	0.000000	0.00001
AVERAGE HEAD ON TOP OF LAYER 15	0.000	
MAXIMUM HEAD ON TOP OF LAYER 15	0.002	
LOCATION OF MAXIMUM HEAD IN LAYER 14 (DISTANCE FROM DRAIN)	0.0 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 16	0.000011	0.04033
SNOW WATER	18.00	65332.0312
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4659	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.2100	

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner

by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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****

FINAL WATER STORAGE AT END OF YEAR 2014

LAYER	(INCHES)	(VOL/VOL)
1	3.9807	0.3317
2	1.1690	0.0974
3	0.0021	0.0103
4	0.0000	0.0000
5	7.6860	0.4270
6	0.3720	0.0620
7	315.3600	0.2920
8	0.5400	0.0450
9	0.0025	0.0100
10	0.0000	0.0000
11	0.1800	0.7500
12	4.6800	0.3900
13	0.5400	0.0450
14	0.0020	0.0100
15	0.0000	0.0000
16	4.6217	0.3851
SNOW WATER	6.551	

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****

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07   (1 NOVEMBER 1997)               **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     C:\HELP3\jrl\expan\DATA4.D4
TEMPERATURE DATA FILE:       C:\HELP3\jrl\expan\DATA7.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\jrl\expan\DATA13.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\jrl\expan\DATA11.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\jrl\expan\90W-TSC.D10
OUTPUT DATA FILE:            C:\HELP3\jrl\expan\90W-TSC.OUT


TIME:  10:28     DATE:  12/19/2014


******************************************************************************

     TITLE:  CASELLA - JUNIPER RIDGE EXPANSION - 18" SOIL COVER (RUNOFF)

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                   LAYER  1
                                   --------

                      TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER  12
           THICKNESS                   =     18.00    INCHES
           POROSITY                    =      0.4710 VOL/VOL
           FIELD CAPACITY              =      0.3420 VOL/VOL
           WILTING POINT               =      0.2100 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.3539 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.419999997000E-04 CM/SEC
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

```
THICKNESS                    =    1080.00    INCHES
POROSITY                     =      0.6710 VOL/VOL
FIELD CAPACITY               =      0.2920 VOL/VOL
WILTING POINT                =      0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.2961 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC
```

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1

```
THICKNESS                    =      12.00    INCHES
POROSITY                     =      0.4170 VOL/VOL
FIELD CAPACITY               =      0.0450 VOL/VOL
WILTING POINT                =      0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.1390 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.999999978000E-02 CM/SEC
```

LAYER 4

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 34

```
THICKNESS                    =       0.25    INCHES
POROSITY                     =      0.8500 VOL/VOL
FIELD CAPACITY               =      0.0100 VOL/VOL
WILTING POINT                =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0241 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =   33.0000000000      CM/SEC
SLOPE                        =       3.00    PERCENT
DRAINAGE LENGTH              =     220.0     FEET
```

LAYER 5

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

```
THICKNESS                    =       0.08    INCHES
POROSITY                     =      0.0000 VOL/VOL
FIELD CAPACITY               =      0.0000 VOL/VOL
WILTING POINT                =      0.0000 VOL/VOL
```

```
INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      3.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD


                        LAYER  6
                        --------

              TYPE 3 - BARRIER SOIL LINER
               MATERIAL TEXTURE NUMBER   0
THICKNESS                   =      0.24   INCHES
POROSITY                    =      0.7500 VOL/VOL
FIELD CAPACITY              =      0.7470 VOL/VOL
WILTING POINT               =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.499999997000E-08 CM/SEC


                        LAYER  7
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER   0
THICKNESS                   =     12.00   INCHES
POROSITY                    =      0.4100 VOL/VOL
FIELD CAPACITY              =      0.3900 VOL/VOL
WILTING POINT               =      0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.3900 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000001000E-06 CM/SEC


                        LAYER  8
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER   1
THICKNESS                   =     12.00   INCHES
POROSITY                    =      0.4170 VOL/VOL
FIELD CAPACITY              =      0.0450 VOL/VOL
WILTING POINT               =      0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.999999978000E-02 CM/SEC


                        LAYER  9
                        --------
```

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.20	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0100	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
SLOPE	=	3.00	PERCENT
DRAINAGE LENGTH	=	400.0	FEET

LAYER 10

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	1.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	3.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 11

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	12.00	INCHES
POROSITY	=	0.4100	VOL/VOL
FIELD CAPACITY	=	0.3900	VOL/VOL
WILTING POINT	=	0.3670	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3898	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-06	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-SPECIFIED CURVE NUMBER OF 79.0, A SURFACE SLOPE OF 5.% AND A SLOPE LENGTH OF 300. FEET.

SCS RUNOFF CURVE NUMBER	=	79.70	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT

```
AREA PROJECTED ON HORIZONTAL PLANE    =      1.000  ACRES
EVAPORATIVE ZONE DEPTH                =      8.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE     =      2.949  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE    =      3.768  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE    =      1.680  INCHES
INITIAL SNOW WATER                    =      1.682  INCHES
INITIAL WATER IN LAYER MATERIALS      =    337.867  INCHES
TOTAL INITIAL WATER                   =    339.549  INCHES
TOTAL SUBSURFACE INFLOW               =      0.00   INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

```
NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
         BANGOR                  MAINE

     STATION LATITUDE                           =  44.80 DEGREES
     MAXIMUM LEAF AREA INDEX                    =   0.00
     START OF GROWING SEASON (JULIAN DATE)      =    134
     END OF GROWING SEASON (JULIAN DATE)        =    263
     EVAPORATIVE ZONE DEPTH                     =   8.0  INCHES
     AVERAGE ANNUAL WIND SPEED                  =   8.70 MPH
     AVERAGE 1ST QUARTER RELATIVE HUMIDITY      =  70.00 %
     AVERAGE 2ND QUARTER RELATIVE HUMIDITY      =  72.00 %
     AVERAGE 3RD QUARTER RELATIVE HUMIDITY      =  77.00 %
     AVERAGE 4TH QUARTER RELATIVE HUMIDITY      =  76.00 %


NOTE:  PRECIPITATION DATA FOR ORONO ME US ORONO ME US
         WAS ENTERED BY THE USER.


NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
         COEFFICIENTS FOR    BANGOR              MAINE
```

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
23.60	16.40	27.90	43.90	53.40	57.60
66.90	72.80	55.70	37.50	31.10	8.90

```
NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
         COEFFICIENTS FOR    BANGOR              MAINE
           AND STATION LATITUDE  =  44.80 DEGREES
```

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1980 THROUGH 2014

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	2.88	2.82	3.19	3.29	3.81	2.96
	3.72	3.41	3.93	3.97	4.09	2.86
STD. DEVIATIONS	1.25	1.29	1.68	1.51	1.81	1.97
	1.79	1.50	2.04	1.72	2.12	1.52
RUNOFF						
TOTALS	0.779	0.126	5.352	5.798	0.139	0.266
	0.228	0.386	0.436	0.198	0.798	0.000
STD. DEVIATIONS	1.033	0.300	3.710	5.230	0.276	0.764
	0.344	0.615	0.956	0.318	0.919	0.001
EVAPOTRANSPIRATION						
TOTALS	0.543	0.390	0.520	1.681	3.018	2.414
	2.802	2.490	2.055	1.290	0.606	0.290
STD. DEVIATIONS	0.080	0.065	0.105	0.660	0.979	1.127
	1.121	0.918	0.625	0.280	0.226	0.050
LATERAL DRAINAGE COLLECTED FROM LAYER 4						
TOTALS	1.2351	0.5084	0.0900	0.0796	0.8142	0.7680
	0.6053	0.4821	0.5945	0.7291	0.9266	1.5155
STD. DEVIATIONS	1.3624	0.8772	0.1112	0.1226	0.4197	0.6293
	0.6158	0.3932	0.4402	0.4904	0.5895	0.9565
PERCOLATION/LEAKAGE THROUGH LAYER 6						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LATERAL DRAINAGE COLLECTED FROM LAYER 9						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 10

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 11

TOTALS	0.0002	0.0001	0.0002	0.0001	0.0001	0.0001
	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
STD. DEVIATIONS	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.0016	0.0007	0.0001	0.0001	0.0010	0.0010
	0.0008	0.0006	0.0008	0.0009	0.0012	0.0019
STD. DEVIATIONS	0.0017	0.0012	0.0001	0.0002	0.0005	0.0008
	0.0008	0.0005	0.0006	0.0006	0.0008	0.0012

DAILY AVERAGE HEAD ON TOP OF LAYER 10

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1980 THROUGH 2014

	INCHES		CU. FEET	PERCENT
PRECIPITATION	40.94	(9.088)	148595.7	100.00
RUNOFF	14.508	(5.7025)	52664.98	35.442
EVAPOTRANSPIRATION	18.098	(2.7951)	65694.50	44.210
LATERAL DRAINAGE COLLECTED FROM LAYER 4	8.34838	(3.23506)	30304.613	20.39400
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00000	(0.00000)	0.008	0.00001
AVERAGE HEAD ON TOP OF LAYER 5	0.001	(0.000)		

LATERAL DRAINAGE COLLECTED FROM LAYER 9	0.00000 (	0.00000)	0.005	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.00000 (	0.00000)	0.004	0.00000
AVERAGE HEAD ON TOP OF LAYER 10	0.000 (	0.000)		
PERCOLATION/LEAKAGE THROUGH LAYER 11	0.00163 (	0.00073)	5.909	0.00398
CHANGE IN WATER STORAGE	-0.020 (	5.3236)	-74.31	-0.050

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PEAK DAILY VALUES FOR YEARS 1980 THROUGH 2014

	(INCHES)	(CU. FT.)
PRECIPITATION	4.80	17424.000
RUNOFF	6.961	25268.7363
DRAINAGE COLLECTED FROM LAYER 4	0.16193	587.80371
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00003
AVERAGE HEAD ON TOP OF LAYER 5	0.006	
MAXIMUM HEAD ON TOP OF LAYER 5	0.013	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	2.4 FEET	
DRAINAGE COLLECTED FROM LAYER 9	0.00000	0.00002
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.000000	0.00001
AVERAGE HEAD ON TOP OF LAYER 10	0.000	
MAXIMUM HEAD ON TOP OF LAYER 10	0.004	
LOCATION OF MAXIMUM HEAD IN LAYER 9 (DISTANCE FROM DRAIN)	0.0 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 11	0.000011	0.04056
SNOW WATER	18.00	65332.0312

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4709
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.2100

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 2014

LAYER	(INCHES)	(VOL/VOL)
1	6.0328	0.3352
2	315.3600	0.2920
3	0.9015	0.0751
4	0.0026	0.0102
5	0.0000	0.0000
6	0.1800	0.7500
7	4.6800	0.3900
8	0.5400	0.0450
9	0.0020	0.0100
10	0.0000	0.0000
11	4.6237	0.3853
SNOW WATER	6.551	

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**                                                                        **
**                                                                        **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE             **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)              **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                 **
**                    USAE WATERWAYS EXPERIMENT STATION                   **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY            **
**                                                                        **
**                                                                        **
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PRECIPITATION DATA FILE:    C:\HELP3\jrl\expan\DATA4.D4
TEMPERATURE DATA FILE:      C:\HELP3\jrl\expan\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\jrl\expan\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\jrl\expan\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\jrl\expan\90W-WRO.D10
OUTPUT DATA FILE:           C:\HELP3\jrl\expan\90W-WRO.OUT


TIME:  14:48     DATE:  12/22/2014


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     TITLE:  CASELLA - JUNIPER RIDGE EXPANSION - OPEN (90' WASTE) WITH RUNOFF

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                   LAYER  1
                                   --------

                         TYPE 1 - VERTICAL PERCOLATION LAYER
                             MATERIAL TEXTURE NUMBER  18
           THICKNESS                  =   1080.00   INCHES
           POROSITY                   =      0.6710 VOL/VOL
           FIELD CAPACITY             =      0.2920 VOL/VOL
           WILTING POINT              =      0.0770 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.2950 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1

```
THICKNESS                     =     12.00   INCHES
POROSITY                      =      0.4170 VOL/VOL
FIELD CAPACITY                =      0.0450 VOL/VOL
WILTING POINT                 =      0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT    =      0.1388 VOL/VOL
EFFECTIVE SAT. HYD. COND.     =  0.999999978000E-02 CM/SEC
```

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 34

```
THICKNESS                     =      0.25   INCHES
POROSITY                      =      0.8500 VOL/VOL
FIELD CAPACITY                =      0.0100 VOL/VOL
WILTING POINT                 =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT    =      0.0240 VOL/VOL
EFFECTIVE SAT. HYD. COND.     =   33.0000000000      CM/SEC
SLOPE                         =      3.00   PERCENT
DRAINAGE LENGTH               =    220.0    FEET
```

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

```
THICKNESS                     =      0.08   INCHES
POROSITY                      =      0.0000 VOL/VOL
FIELD CAPACITY                =      0.0000 VOL/VOL
WILTING POINT                 =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT    =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.     =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY           =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS      =      3.00   HOLES/ACRE
FML PLACEMENT QUALITY         =  3 - GOOD
```

LAYER 5

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 0

```
THICKNESS                     =      0.24   INCHES
```

```
POROSITY                      =      0.7500 VOL/VOL
FIELD CAPACITY                =      0.7470 VOL/VOL
WILTING POINT                 =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT    =      0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.     =  0.499999997000E-08 CM/SEC


                        LAYER  6
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                     =     12.00   INCHES
POROSITY                      =      0.4100 VOL/VOL
FIELD CAPACITY                =      0.3900 VOL/VOL
WILTING POINT                 =      0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT    =      0.3900 VOL/VOL
EFFECTIVE SAT. HYD. COND.     =  0.100000001000E-06 CM/SEC


                        LAYER  7
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   1
THICKNESS                     =     12.00   INCHES
POROSITY                      =      0.4170 VOL/VOL
FIELD CAPACITY                =      0.0450 VOL/VOL
WILTING POINT                 =      0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT    =      0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND.     =  0.999999978000E-02 CM/SEC


                        LAYER  8
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER  20
THICKNESS                     =      0.20   INCHES
POROSITY                      =      0.8500 VOL/VOL
FIELD CAPACITY                =      0.0100 VOL/VOL
WILTING POINT                 =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT    =      0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND.     =   10.0000000000      CM/SEC
SLOPE                         =      3.00   PERCENT
DRAINAGE LENGTH               =    400.0    FEET


                        LAYER  9
```

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

```
THICKNESS                  =      0.06    INCHES
POROSITY                   =      0.0000 VOL/VOL
FIELD CAPACITY             =      0.0000 VOL/VOL
WILTING POINT              =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY        =      1.00    HOLES/ACRE
FML INSTALLATION DEFECTS   =      3.00    HOLES/ACRE
FML PLACEMENT QUALITY      =  3 - GOOD
```

LAYER 10

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

```
THICKNESS                  =     12.00    INCHES
POROSITY                   =      0.4100 VOL/VOL
FIELD CAPACITY             =      0.3900 VOL/VOL
WILTING POINT              =      0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.3898 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000001000E-06 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-
SPECIFIED CURVE NUMBER OF 55.0, A SURFACE SLOPE
OF 5.% AND A SLOPE LENGTH OF 300. FEET.

```
SCS RUNOFF CURVE NUMBER            =     57.00
FRACTION OF AREA ALLOWING RUNOFF   =    100.0     PERCENT
AREA PROJECTED ON HORIZONTAL PLANE =      1.000   ACRES
EVAPORATIVE ZONE DEPTH             =      8.0     INCHES
INITIAL WATER IN EVAPORATIVE ZONE  =      2.133   INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE =      5.368   INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE =      0.616   INCHES
INITIAL SNOW WATER                 =      1.682   INCHES
INITIAL WATER IN LAYER MATERIALS   =    330.338   INCHES
TOTAL INITIAL WATER                =    332.020   INCHES
TOTAL SUBSURFACE INFLOW            =      0.00    INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
BANGOR MAINE

STATION LATITUDE	=	44.80 DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00
START OF GROWING SEASON (JULIAN DATE)	=	134
END OF GROWING SEASON (JULIAN DATE)	=	263
EVAPORATIVE ZONE DEPTH	=	8.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	8.70 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	70.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	72.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	77.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	76.00 %

NOTE: PRECIPITATION DATA FOR ORONO ME US ORONO ME US
WAS ENTERED BY THE USER.

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR BANGOR MAINE

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
23.60	16.40	27.90	43.90	53.40	57.60
66.90	72.80	55.70	37.50	31.10	8.90

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR BANGOR MAINE
AND STATION LATITUDE = 44.80 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1980 THROUGH 2014

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	2.88	2.82	3.19	3.29	3.81	2.96
	3.72	3.41	3.93	3.97	4.09	2.86
STD. DEVIATIONS	1.25	1.29	1.68	1.51	1.81	1.97
	1.79	1.50	2.04	1.72	2.12	1.52
RUNOFF						
TOTALS	0.518	0.071	4.494	5.290	0.004	0.004
	0.000	0.000	0.007	0.006	0.369	0.000
STD. DEVIATIONS	0.779	0.187	3.583	4.864	0.021	0.020
	0.000	0.003	0.043	0.033	0.626	0.000
EVAPOTRANSPIRATION						
TOTALS	0.543	0.390	0.520	1.782	3.403	2.698
	2.997	2.801	2.189	1.307	0.605	0.290
STD. DEVIATIONS	0.080	0.065	0.105	0.696	1.021	1.257
	1.216	1.037	0.663	0.277	0.225	0.050
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	1.1969	0.4281	0.1791	0.1826	1.8790	1.1510
	0.7463	0.5900	0.5977	0.8538	1.1432	1.6963
STD. DEVIATIONS	1.3740	0.7964	0.5663	0.3565	0.5135	1.0050
	0.9290	0.6513	0.5997	0.6822	0.7108	1.1343
PERCOLATION/LEAKAGE THROUGH LAYER 5						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LATERAL DRAINAGE COLLECTED FROM LAYER 8						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 9

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 10

TOTALS	0.0002	0.0001	0.0002	0.0001	0.0001	0.0001
	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
STD. DEVIATIONS	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0015	0.0006	0.0002	0.0002	0.0024	0.0015
	0.0009	0.0007	0.0008	0.0011	0.0015	0.0021
STD. DEVIATIONS	0.0017	0.0011	0.0007	0.0005	0.0006	0.0013
	0.0012	0.0008	0.0008	0.0009	0.0009	0.0014

DAILY AVERAGE HEAD ON TOP OF LAYER 9

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1980 THROUGH 2014

	INCHES	CU. FEET	PERCENT
PRECIPITATION	40.94 (9.088)	148595.7	100.00
RUNOFF	10.762 (4.7361)	39067.38	26.291
EVAPOTRANSPIRATION	19.526 (3.1060)	70878.08	47.699
LATERAL DRAINAGE COLLECTED FROM LAYER 3	10.64406 (4.27971)	38637.953	26.00207
PERCOLATION/LEAKAGE THROUGH	0.00000 (0.00000)	0.009	0.00001

LAYER 5				
AVERAGE HEAD ON TOP OF LAYER 4	0.001 (	0.000)		
LATERAL DRAINAGE COLLECTED FROM LAYER 8	0.00000 (	0.00000)	0.005	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.00000 (	0.00000)	0.004	0.00000
AVERAGE HEAD ON TOP OF LAYER 9	0.000 (	0.000)		
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.00165 (	0.00075)	6.000	0.00404
CHANGE IN WATER STORAGE	0.002 (	5.9432)	6.28	0.004

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PEAK DAILY VALUES FOR YEARS 1980 THROUGH 2014

	(INCHES)	(CU. FT.)
PRECIPITATION	4.80	17424.000
RUNOFF	6.771	24580.2773
DRAINAGE COLLECTED FROM LAYER 3	0.17874	648.81573
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00003
AVERAGE HEAD ON TOP OF LAYER 4	0.007	
MAXIMUM HEAD ON TOP OF LAYER 4	0.014	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	0.0 FEET	
DRAINAGE COLLECTED FROM LAYER 8	0.00000	0.00002
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.000000	0.00002
AVERAGE HEAD ON TOP OF LAYER 9	0.000	
MAXIMUM HEAD ON TOP OF LAYER 9	0.004	
LOCATION OF MAXIMUM HEAD IN LAYER 8 (DISTANCE FROM DRAIN)	0.0 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.000011	0.04059
SNOW WATER	18.00	65332.0312

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.6541

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0770

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 2014

LAYER	(INCHES)	(VOL/VOL)
1	314.5916	0.2913
2	0.9073	0.0756
3	0.0026	0.0102
4	0.0000	0.0000
5	0.1800	0.7500
6	4.6800	0.3900
7	0.5400	0.0450
8	0.0020	0.0100
9	0.0000	0.0000
10	4.6228	0.3852
SNOW WATER	6.551	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                 DEVELOPED BY ENVIRONMENTAL LABORATORY                    **
**                   USAE WATERWAYS EXPERIMENT STATION                      **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:     C:\HELP3\jrl\expan\DATA4.D4
TEMPERATURE DATA FILE:       C:\HELP3\jrl\expan\DATA7.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\jrl\expan\DATA13.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\jrl\expan\DATA11.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\jrl\expan\10W-WRO.D10
OUTPUT DATA FILE:            C:\HELP3\jrl\expan\10W-WRO.OUT


TIME:  10:28     DATE:  12/19/2014


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     TITLE:  CASELLA - JUNIPER RIDGE EXPANSION - OPEN (10' WASTE)

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                    TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER  18
           THICKNESS                     =    120.00   INCHES
           POROSITY                      =      0.6710 VOL/VOL
           FIELD CAPACITY                =      0.2920 VOL/VOL
           WILTING POINT                 =      0.0770 VOL/VOL
           INITIAL SOIL WATER CONTENT    =      0.2903 VOL/VOL
           EFFECTIVE SAT. HYD. COND.     =  0.100000005000E-02 CM/SEC
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1

THICKNESS	=	12.00 INCHES
POROSITY	=	0.4170 VOL/VOL
FIELD CAPACITY	=	0.0450 VOL/VOL
WILTING POINT	=	0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1082 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999978000E-02 CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 34

THICKNESS	=	0.25 INCHES
POROSITY	=	0.8500 VOL/VOL
FIELD CAPACITY	=	0.0100 VOL/VOL
WILTING POINT	=	0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0140 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	33.0000000000 CM/SEC
SLOPE	=	3.00 PERCENT
DRAINAGE LENGTH	=	220.0 FEET

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.08 INCHES
POROSITY	=	0.0000 VOL/VOL
FIELD CAPACITY	=	0.0000 VOL/VOL
WILTING POINT	=	0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY	=	1.00 HOLES/ACRE
FML INSTALLATION DEFECTS	=	3.00 HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD

LAYER 5

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	0.24 INCHES

```
POROSITY                    =     0.7500 VOL/VOL
FIELD CAPACITY              =     0.7470 VOL/VOL
WILTING POINT               =     0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT  =     0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.499999997000E-08 CM/SEC


                       LAYER  6
                       --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                   =    12.00   INCHES
POROSITY                    =     0.4100 VOL/VOL
FIELD CAPACITY              =     0.3900 VOL/VOL
WILTING POINT               =     0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT  =     0.3900 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000001000E-06 CM/SEC


                       LAYER  7
                       --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   1
THICKNESS                   =    12.00   INCHES
POROSITY                    =     0.4170 VOL/VOL
FIELD CAPACITY              =     0.0450 VOL/VOL
WILTING POINT               =     0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT  =     0.0450 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.999999978000E-02 CM/SEC


                       LAYER  8
                       --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER  20
THICKNESS                   =     0.20   INCHES
POROSITY                    =     0.8500 VOL/VOL
FIELD CAPACITY              =     0.0100 VOL/VOL
WILTING POINT               =     0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT  =     0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =   10.0000000000      CM/SEC
SLOPE                       =     3.00   PERCENT
DRAINAGE LENGTH             =   400.0    FEET


                       LAYER  9
```

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06 INCHES
POROSITY	=	0.0000 VOL/VOL
FIELD CAPACITY	=	0.0000 VOL/VOL
WILTING POINT	=	0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY	=	1.00 HOLES/ACRE
FML INSTALLATION DEFECTS	=	3.00 HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD

LAYER 10

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	12.00 INCHES
POROSITY	=	0.4100 VOL/VOL
FIELD CAPACITY	=	0.3900 VOL/VOL
WILTING POINT	=	0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3898 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-06 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-SPECIFIED CURVE NUMBER OF 55.0, A SURFACE SLOPE OF 5.% AND A SLOPE LENGTH OF 300. FEET.

SCS RUNOFF CURVE NUMBER	=	57.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.133	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	5.368	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.616	INCHES
INITIAL SNOW WATER	=	1.682	INCHES
INITIAL WATER IN LAYER MATERIALS	=	46.218	INCHES
TOTAL INITIAL WATER	=	47.900	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
BANGOR MAINE

STATION LATITUDE	=	44.80 DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00
START OF GROWING SEASON (JULIAN DATE)	=	134
END OF GROWING SEASON (JULIAN DATE)	=	263
EVAPORATIVE ZONE DEPTH	=	8.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	8.70 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	70.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	72.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	77.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	76.00 %

NOTE: PRECIPITATION DATA FOR ORONO ME US ORONO ME US
WAS ENTERED BY THE USER.

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR BANGOR MAINE

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
23.60	16.40	27.90	43.90	53.40	57.60
66.90	72.80	55.70	37.50	31.10	8.90

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR BANGOR MAINE
AND STATION LATITUDE = 44.80 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1980 THROUGH 2014

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	2.88	2.82	3.19	3.29	3.81	2.96
	3.72	3.41	3.93	3.97	4.09	2.86
STD. DEVIATIONS	1.25	1.29	1.68	1.51	1.81	1.97
	1.79	1.50	2.04	1.72	2.12	1.52
RUNOFF						
TOTALS	0.518	0.071	4.494	5.290	0.004	0.004
	0.000	0.000	0.007	0.006	0.369	0.000
STD. DEVIATIONS	0.779	0.187	3.583	4.864	0.021	0.020
	0.000	0.003	0.043	0.033	0.626	0.000
EVAPOTRANSPIRATION						
TOTALS	0.543	0.390	0.520	1.782	3.403	2.698
	2.997	2.801	2.189	1.307	0.605	0.290
STD. DEVIATIONS	0.080	0.065	0.105	0.696	1.021	1.257
	1.216	1.037	0.663	0.277	0.225	0.050
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.2006	0.0577	0.0396	0.3929	2.3427	0.7989
	0.4419	0.5739	0.6518	1.2647	2.0238	1.7412
STD. DEVIATIONS	0.2170	0.0178	0.0088	0.6278	0.7247	0.9432
	0.6359	0.7059	0.8157	1.3462	1.5733	1.4444
PERCOLATION/LEAKAGE THROUGH LAYER 5						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LATERAL DRAINAGE COLLECTED FROM LAYER 8						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 9						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 10

TOTALS	0.0002	0.0001	0.0002	0.0001	0.0001	0.0001
	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
STD. DEVIATIONS	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0003	0.0001	0.0001	0.0005	0.0030	0.0010
	0.0006	0.0007	0.0009	0.0016	0.0026	0.0022
STD. DEVIATIONS	0.0003	0.0000	0.0000	0.0008	0.0009	0.0012
	0.0008	0.0009	0.0011	0.0017	0.0021	0.0018

DAILY AVERAGE HEAD ON TOP OF LAYER 9

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

****
****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1980 THROUGH 2014

	INCHES	CU. FEET	PERCENT
PRECIPITATION	40.94 (9.088)	148595.7	100.00
RUNOFF	10.762 (4.7361)	39067.38	26.291
EVAPOTRANSPIRATION	19.526 (3.1060)	70878.08	47.699
LATERAL DRAINAGE COLLECTED FROM LAYER 3	10.52969 (4.53332)	38222.777	25.72267
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00000 (0.00000)	0.009	0.00001
AVERAGE HEAD ON TOP OF LAYER 4	0.001 (0.000)		

LATERAL DRAINAGE COLLECTED FROM LAYER 8	0.00000 (	0.00000)	0.004	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.00000 (	0.00000)	0.005	0.00000
AVERAGE HEAD ON TOP OF LAYER 9	0.000 (	0.000)		
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.00166 (	0.00076)	6.035	0.00406
CHANGE IN WATER STORAGE	0.116 (	4.4486)	421.42	0.284

****
****

PEAK DAILY VALUES FOR YEARS 1980 THROUGH 2014

	(INCHES)	(CU. FT.)
PRECIPITATION	4.80	17424.000
RUNOFF	6.771	24580.2773
DRAINAGE COLLECTED FROM LAYER 3	0.47826	1736.09839
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00005
AVERAGE HEAD ON TOP OF LAYER 4	0.019	
MAXIMUM HEAD ON TOP OF LAYER 4	0.038	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	0.0 FEET	
DRAINAGE COLLECTED FROM LAYER 8	0.00000	0.00002
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.000000	0.00002
AVERAGE HEAD ON TOP OF LAYER 9	0.000	
MAXIMUM HEAD ON TOP OF LAYER 9	0.004	
LOCATION OF MAXIMUM HEAD IN LAYER 8 (DISTANCE FROM DRAIN)	0.0 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.000011	0.04045
SNOW WATER	18.00	65332.0312

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.6541

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0770

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

****
****

FINAL WATER STORAGE AT END OF YEAR 2014

LAYER	(INCHES)	(VOL/VOL)
1	34.2717	0.2856
2	0.8815	0.0735
3	0.0025	0.0102
4	0.0000	0.0000
5	0.1800	0.7500
6	4.6800	0.3900
7	0.5400	0.0450
8	0.0020	0.0100
9	0.0000	0.0000
10	4.6224	0.3852
SNOW WATER	6.551	

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BGS/NEWSME 54

BGS/NEWSME EXHIBIT #54

BANGOR DAILY NEWS JUNE 25, 2012

ARTICLE ON THE BROWNVILLE STORM

VIDEO

Brownville flooding was almost a perfect storm, meteorologist says

By Nick Sambides Jr. (http://bangordailynews.com/author/nick-sambides-jr/) (http://bangordailynews.com/author/nick-sambides-jr/), BDN Staff

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BROWNVILLE, Maine — It wasn't a perfect storm, but the heavy rainfall that flooded Brownville (http://bangordailynews.com/2012/06/24/news/brownville-streets-power-cut-off-by-flooding-one-dead-after-crash-on-washed-out-road/?ref=inline) over the weekend was about as close as meteorologist Ken Wallingford expects to see.

The storm, Wallingford said, dumped at least 6 inches of rain on the town in two or three hours, and about 8 inches overall, because of random meteorological events not unlike those in the movie "The Perfect Storm" (http://www.youtube.com/watch?v=gVwuy-4TzU8) featuring George Clooney.

"In a perfect world and almost all the time, weather systems move, and that's a good thing," Wallingford said Monday. "It's very rare that you have situations where things come together the way they did on Saturday night."

A meteorologist with the National Weather Service in Caribou (http://www.erh.noaa.gov/er/car/), Wallingford said the Brownville storm resembled the perfect storm in that it was a large system that gathered great force and stalled.

"For something of that magnitude to sit there for that long like it did is a very rare occurrence," Wallingford said.

The storm hit Brownville especially hard because the area's steep hills gave the flooding greater force. The ground had been pretty well soaked by previous storms, Wallingford said. He did not know why the storm stalled over the town.

One big difference between Brownville's storm and that in the movie, which is based on a nonfiction novel by Sebastian Junger: "The Perfect Storm" was actually two weather systems that merged and stalled, not one.

Still, the one that hit Brownville was enough for Mike Washburn, who operates Joe's Repair Shop at 270 Main Road with his father, Joe.

The younger Washburn was home at 7:30 p.m. Saturday feeling pretty good after having had a beer when he got a call that he had better come back to work. When he arrived, Washburn saw waist-high water flowing down the steep incline of High Street into the shop, enough to separate the garage's cement-slab floor from its walls.

"The whole slab was dropping out and you could see the outside of the shop through the hole from the inside," Washburn said.

"That," Washburn added, "was a real buzz kill."

A half-dozen Maine Department of Transportation workers rebuilt High Street on Sunday and were finishing trenches along the road on Monday as Washburn and workers with a private company repaired the shop. On Tuesday, the MDOT crews will install driveway pipes along the road, said Bob Davis, a state crew supervisor.

"I haven't seen anything like this since the 1987 flood," Davis said.

Milo resident Keith Porter speculated that the High and Church streets intersection with Route 11 was the storm's ground zero. He drove through on Sunday morning and couldn't believe there was no news of the storm's impact on Brownville.

The storm was difficult to predict because the area hit was so small, Wallingford said.

"We didn't know what happened," Porter said. "People who came through and saw it were just dumbfounded. Never seen anything like this before."

CORRECTION:

An earlier version of this story incorrectly attributed a quote. "The storm was difficult to predict because the area hit was so small," should be attributed to Ken Wallingford, not Mike Washburn.

Recommend this article

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BGS/ NEWSME EXHIBIT #55

RAINFALL AMOUNTS FOR 2003 AND SEPTEMBER 30, 2015

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Environmental Satellite, Data, and Information Service

Record of Climatological Observations

These data are quality controlled and may not be identical to the original observations.
Generated on 08/16/2016

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

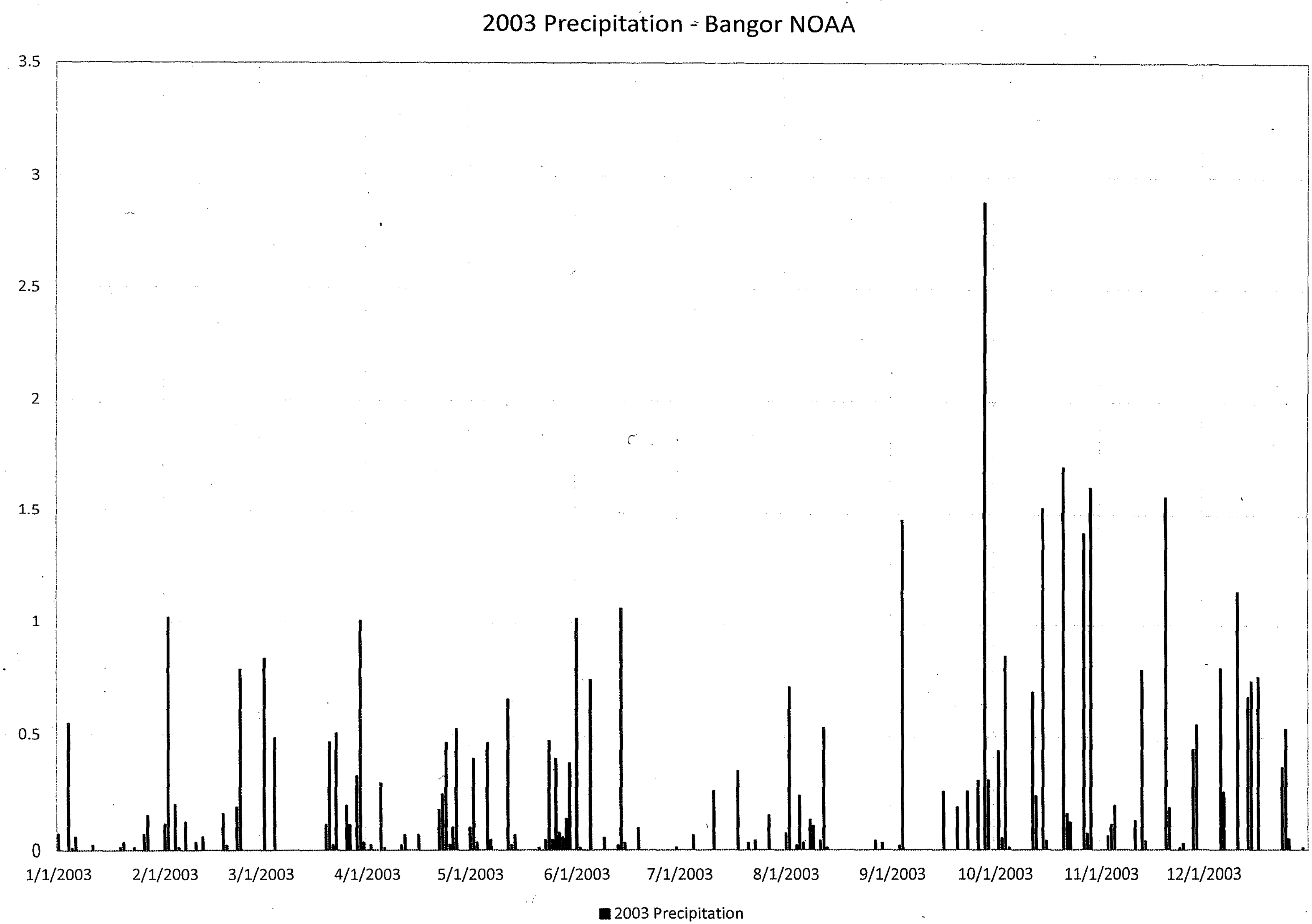
Elev: 148 ft. Lat: 44.798° N Lon: 68.818° W

Station: **BANGOR INTERNATIONAL AIRPORT, ME US GHCND:USW00014606**

Observation Time Temperature: Unknown Observation Time Precipitation: 2400

Preliminary	Year	Month	Day	Temperature (F) 24 hrs. ending at observation time Max.	Min.	at Observation	Precipitation 24 Hour Amounts ending at observation time Rain, melted snow, etc. (in)	Flag	Snow, ice pellets, hail (in)	Flag	At Obs Time Snow, ice pellets, hail, ice on ground (in)	Evaporation 24 Hour Wind Movement (mi)	Amount of Evap. (in)	Soil Temperature (F) 4 in depth Ground Cover (see *)	Max.	Min.	8 in depth Ground Cover (see *)	Max.	Min.
	2015	9	1	78	57		0.00		0.0		0.0								
	2015	9	2	85	56		0.00		0.0		0.0								
	2015	9	3	86	60		0.00		0.0		0.0								
	2015	9	4	75	50		0.00		0.0		0.0								
	2015	9	5	82	46		0.00		0.0		0.0								
	2015	9	6	87	53		0.00		0.0		0.0								
	2015	9	7	89	62		0.00		0.0		0.0								
	2015	9	8	86	67		0.01		0.0		0.0								
	2015	9	9	85	65		0.00		0.0		0.0								
	2015	9	10	75	67		0.00		0.0		0.0								
	2015	9	11	67	57		0.55		0.0		0.0								
	2015	9	12	76	55		0.00		0.0		0.0								
	2015	9	13	67	57		0.46		0.0		0.0								
	2015	9	14	74	59		0.29		0.0		0.0								
	2015	9	15	82	59		0.00		0.0		0.0								
	2015	9	16	84	58		0.00		0.0		0.0								
	2015	9	17	86	57		0.00		0.0		0.0								
	2015	9	18	85	57		0.00		0.0		0.0								
	2015	9	19	78	55		0.00		0.0		0.0								
	2015	9	20	67	46		0.10		0.0		0.0								
	2015	9	21	70	38		0.00		0.0		0.0								
	2015	9	22	67	44		0.00		0.0		0.0								
	2015	9	23	76	42		0.00		0.0		0.0								
	2015	9	24	72	47		0.00		0.0		0.0								
	2015	9	25	57	39		0.00		0.0		0.0								
	2015	9	26	63	35		0.00		0.0		0.0								
	2015	9	27	70	34		0.00		0.0		0.0								
	2015	9	28	76	46		0.00		0.0		0.0								
	2015	9	29	79	62		0.21		0.0		0.0								
*	2015	9	30	67	53		5.27		0.0		0.0								
			Summary	76	53		6.89		0.0										

The "*" flags in Preliminary indicate the data have not completed processing and qualitycontrol and may not be identical to the original observation
Empty, or blank, cells indicate that a data observation was not reported.
*Ground Cover: 1=Grass; 2=Fallow; 3=Bare Ground; 4=Brome grass; 5=Sod; 6=Straw mulch; 7=Grass muck; 8=Bare muck; 0=Unknown
"s" This data value failed one of NCDC's quality control tests.
"T" values in the Precipitation category above indicate a TRACE value was recorded.
"A" values in the Precipitation Flag or the Snow Flag column indicate a multiday total, accumulated since last measurement, is being used.
Data value inconsistency may be present due to rounding calculations during the conversion process from SI metric units to standard imperial units.

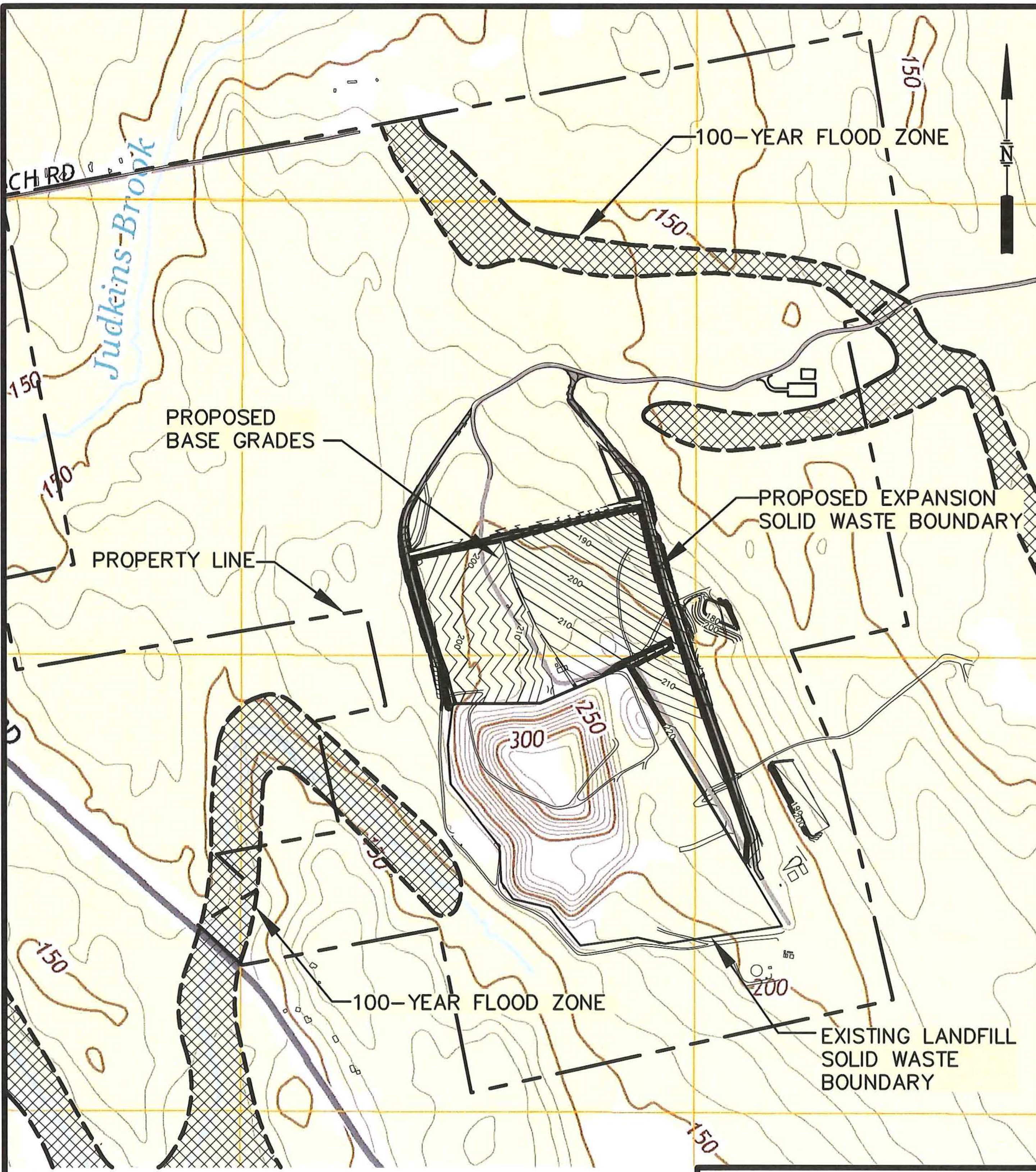


2003 Precipitation - Bangor NOAA
3.5
3
2.5
2
1.5
1
0.5
0
1/1/2003
2/1/2003
3/1/2003
4/1/2003
5/1/2003
6/1/2003
7/1/2003
8/1/2003
9/1/2003
10/1/2003
11/1/2003
12/1/2003
2003 Precipitation

BGS/NEWSME 56

BGS/NEWSME EXHIBIT #56

FIGURE SHOWING FLOODPLAIN ELEVATIONS



NOTES

1. BASE MAP ADAPTED FROM 7.5 MIN USGS TOPOGRAPHIC QUADRANGLE OLD TOWN, MAINE-2014

2. 100 YEAR FLOOD ZONE (FEMA OLD TOWN QUAD PANEL NUMBER 2301120002A DATED APRIL 1978)

500 0 1000 2000 FEET

BGS/NEWSME EXHIBIT 56
FLOODPLAIN FIGURE
JUNIPER RIDGE LANDFILL EXPANSION
OLD TOWN, MAINE

SME
Sevee & Maher Engineers, Inc.
ENVIRONMENTAL · CIVIL · GEOTECHNICAL · WATER · COMPLIANCE

DWG: SITELOC LMN:Floodplain CTB: sme-std REV: 9/6/2016

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Emerson, Bryan P.

Pre-Filed Rebuttal Testimony of Bryan Emerson

Before the Board of Environmental Protection

Juniper Ridge Landfill

DEP Application S-020700-WD-BI-N, L-024251-TG-C-N

The purpose of this rebuttal testimony is to respond to the pre-filed testimony of Steve Coghlan, expert witness for Edward S. Spencer, who is an intervenor for the Juniper Ridge Landfill (JRL) expansion application filed by the Bureau of General Services (BGS) and NEWSME Landfill Operations, LLC (NEWSME). In particular, I will respond to testimony from Mr. Coghlan regarding: 1) impacts to Atlantic salmon (*Salmo salar*), Atlantic sturgeon (*Acipenser oxyrhynchus oxyrhynchus*) and shortnose sturgeon (*Acipenser brevirostrum*), and 2) preservation as a form of wetland compensation.

I. Impacts to Atlantic Salmon, Atlantic Sturgeon and Shortnose Sturgeon

Mr. Coghlan provides a lengthy biological summary and historical background of Atlantic salmon populations throughout North America and discusses general reasons for their decline. He then questions whether statements made in the application regarding lack of adverse impacts to Atlantic salmon are reasonable. See Coghlan Testimony at 4. First and foremost, it is important to note that during state natural resource agency review of the JRL expansion application, Oliver Cox of the Maine Department of Marine Resources (MDMR) stated in an email on 1 February 2016 to Lynn Caron of the Maine Department of Environmental Protection (MDEP) that "none of the stream[s] in the project area are Atlantic salmon stream[s]." Further, John Perry of the Maine Department of Inland Fisheries and Wildlife commented on the expansion application in an email to Lynn Caron on 16 October 2015 that "fisheries staff do not anticipate any adverse impacts on fisheries resources associated with this landfill expansion." See BGS/NEWSME Exhibit #57. It is also noteworthy that Atlantic salmon are not a state listed threatened or endangered species as defined in the Maine Endangered Species Act or Maine's Marine Endangered Species Act. On the basis of this information alone, I believe the statements made in the application are, contrary to Mr. Coghlan's testimony, reasonable. To further address Mr. Coghlan's testimony, however, we offer the following additional information.

The assessment of impact on Atlantic salmon, a federally listed endangered species, was evaluated considering multiple factors. First, when considering impacts to Atlantic salmon, the first question is whether any streams will be directly impacted by the proposed project. As stated throughout the expansion application, and as acknowledged by Mr. Coghlan, the proposed expansion does not directly impact any river, stream or brook. In addition, the largest wetland being impacted in the middle of the proposed expansion is an isolated forested wetland with no surface hydrological connection to a stream or floodplain wetlands, and the wetlands being impacted on the edge of the expansion are not floodplain wetlands. Therefore, no direct impacts to Atlantic salmon or their habitat are likely to occur.

Second, to further assess potential indirect impacts, Stantec considered the proximity of the project to stream resources. For the proposed JRL expansion, the closest stream resource to the proposed landfill cells is an unnamed intermittent stream located approximately 800 feet to the east of the proposed landfill cells. This stream is located within federally mapped Atlantic salmon Critical Habitat and drains to the north, ultimately flowing into an unnamed USGS-mapped stream after flowing approximately 4,000 feet along the course of the stream. The next closest stream is located approximately 950 feet southwest of the proposed landfill cells. This unnamed stream flows northwest before looping to the south and joining with Pushaw Stream after approximately 3.2 miles along the course of the stream. Neither this stream, nor Pushaw Stream, is located within federally mapped Atlantic salmon Critical Habitat. Finally, Judkins Brook, located to the north of the JRL expansion, is within federally mapped Critical Habitat, but is located in a different watershed than the landfill expansion and approximately 2,350 feet from the edge of the proposed landfill cells. See BGS/NEWSME Exhibit #58. Given these distances, the proposed JRL expansion provides large undisturbed, forested buffers to stream resources that are in excess of stream buffers recommended in the scientific literature and by natural resource agencies. These buffers minimize the risk of indirect impacts to Atlantic salmon as a result of the proposed expansion.

This impact assessment is supported by regional and national research and natural resource agencies' guidance on buffer widths, which conclude that a buffer width of approximately 75 to 100 feet is recommended to maintain water quality and habitat for biological resources (i.e., fish). In a national buffer width literature review paper, Castelle et al. 1994 (BGS/NEWSME Exhibit #59) concluded that a minimum buffer width between 49 feet and 98 feet should be implemented for the protection of wetlands and streams and that buffer widths in the upper end of that range appear to be the minimum width necessary for the maintenance of the biological components of wetlands and streams. Castelle et al. 1994 reviewed studies that addressed the various functions that buffers provide, including sediment removal, erosion control, nutrient and metal removal, moderation of stormwater runoff, moderation of water temperature, maintenance of habitat diversity, wildlife species distribution and diversity, and reduction of human impact. Considering all of these buffer functions, the buffer widths provided at the JRL expansion far exceed the conclusions of Castelle et al. 1994. Further, Wilkerson et al. 2006 (BGS/NEWSME Exhibit #60) concluded that buffers at least 75 feet wide with greater than 60% canopy closure resulted in no detectable temperature changes in 15 small headwater streams in Maine. The MDIFW also recommends limiting the harvest of trees and alteration of other vegetation within 100 feet of streams and their associated fringe and floodplain wetlands for the protection of brook trout habitat and water quality (BGS/NEWSME Exhibit #61). Finally, Chapter 310 of MDEP's regulations establishes a distance of 75 feet to consider activities that are adjacent to protected natural resources to provide additional protection to streams and other protected natural resources. The U.S. Army Corps of Engineers does not have a prescribed buffer for streams, but only requires compensation for temporary or secondary impacts within

100 feet of streams, recognizing that impacts to stream buffers within 100 feet of streams can affect the functions of streams. Compensation is not required for impacts at distances beyond 100 feet. See BGS/NEWSME Exhibit #62, Section 3.g, Table 2.

Based on this information, the buffer widths from the proposed landfill expansion to adjacent streams, all greater than 800 feet, far exceed those recommended in the scientific literature for biological protection, and guidance from natural resource agencies on buffer widths.

On page 5 of his testimony, Mr. Coghlan recommends considering impacts and effects of the expansion on shortnose and Atlantic sturgeon. He asks, "Even though their habitat does not extend upstream into watersheds on JRL property, shouldn't we consider downstream effects on their habitat?" Shortnose sturgeon is state listed in Maine as endangered; however, their current known range is limited to the main stem of the Penobscot River. Atlantic sturgeon is not listed by the State of Maine as threatened or endangered and their known habitat is similarly limited to the main stem of the Penobscot River. As discussed above, there are no direct impacts to streams by the landfill expansion and the closest tributaries to streams and/or brooks (i.e., Judkins and Pushaw) are located more than 800 feet away from the current expansion. The closest points on those two streams are then approximately 6.5 river miles (Judkins) and 8.4 river miles (Pushaw) upstream from the Stillwater River, which flows another approximately 6 - 8 river miles before it reaches the main stem of the Penobscot River.

Given the extensive vegetated buffers between the expansion and adjacent streams, which far exceed recommendations from the literature and regulatory agencies, and the geographical location of the expansion more than 12 river miles upstream from the main stem of the Penobscot River, it is highly unlikely that there will be adverse impacts to shortnose or Atlantic sturgeon as a result of the JRL expansion.

II. Preservation as Wetland Compensation

At the end of Mr. Coghlan's testimony, he addresses the issue of wetland compensation. He states that he does not "agree that 'compensation' = 'preservation'." See Coghlan Testimony at 15. As described in Chapter 310 of the NRPA, Wetlands and Waterbodies Protection, compensation for wetland alterations can be achieved in multiple ways. Section 5(C)(4) lists the "Types of compensation" allowed for wetland alterations, including Section 5(C)(4)(c), which lists one of the forms of compensation as "Preservation of existing wetlands or adjacent uplands where the site to be preserved provides significant wetland functions and might otherwise be degraded by unregulated activities." As described in the Application (see Volume V, Attachment 13, Wetland Compensation Plan) and in my direct pre-filed testimony, the proposed preservation area provides far greater wetland functions and values than the wetlands to be impacted. The proposed preservation area meets the standards of Chapter 310. While Mr. Coghlan may not agree that preservation is an acceptable method of compensation, that is the law in Maine, and this project complies with that law.

Dated: 9/7/16

Bryan P. Emerson

STATE OF MAINE

Sagadahoc, ss.

Personally appeared before me the above-named Bryan P. Emerson and made oath that the foregoing is true and accurate to the best of his knowledge and belief.

Before me,

Dated: 9/7/16

Notary Public
Name: Carrie M. Marthia
My Commission Expires: 10/21/2017

Carrie M. Marthia
Notary Public, Maine
My Commission Expires 10/21/2017

BGS/NEWSME 57

Caron, Lynn A

From:	Cox, Oliver N
Sent:	Monday, February 01, 2016 11:27 AM
To:	Caron, Lynn A
Subject:	RE: Juniper Ridge Landfill

Hi Lynn,

None of the stream in the project area are Atlantic salmon stream.

Oliver

Oliver Cox
Maine Department of Marine Resources
Division of Sea Run Fisheries and Habitat
650 State Street, Bangor, Maine 04401
207.941.4487

Division Mission
To protect, conserve, restore, manage and enhance diadromous fish populations and their habitat in all waters of the State; to secure a sustainable recreational fishery for diadromous species; and to conduct and coordinate projects involving research, planning, management, restoration or propagation of diadromous fishes.

From: Caron, Lynn A
Sent: Monday, January 25, 2016 9:01 AM
To: Cox, Oliver N
Subject: RE: Juniper Ridge Landfill

Hi Oliver:
The review request may actually have come from Michael Parker, he is the head project manager on application. I sent the review request to him and he bundled all the request for consistency. He may have decided that ASC review was not necessary. Anyway here is the a copy of the original review. Since the application is so large, we have been referring reviewers to the Maine DEP website. At the bottom of the home page is an icon for major projects before the DEP. You can access the application by going to that site.
Sorry to take you unawares, it is probably a misunderstanding on my part.
Lynn

From: Cox, Oliver N
Sent: Monday, January 25, 2016 8:42 AM
To: Caron, Lynn A
Subject: RE: Juniper Ridge Landfill

Hi Lynn,

I cannot find any emails on this topic. Can you send (or resend, if that is the case) the documents or link for the project.

Thank you,
Oliver

Caron, Lynn A

From:	Perry, John
Sent:	Friday, October 16, 2015 10:35 AM
To:	Parker, Michael T
Cc:	Starr, Allen; Kramer, Gordon
Subject:	Juniper Ridge Landfill Expansion S-020700-WD-BI-N

Hi Michael,

Wildlife Concerns

Minimal additional impacts to wildlife are anticipated.

Fisheries Concerns

Judkins Brook and an unnamed tributary to Pushaw Stream are in close proximity to the project but fall outside of the project boundaries. Based upon the proposal as presented, fisheries staff do not anticipate any adverse impacts on fisheries resources associated with this landfill expansion. However, if in the future there are any stream crossings proposed or any changes to the scope or nature of this proposal MDIFW would appreciate an opportunity for further review.

Thank you, and please let me know if you need additional information.

John

John Perry
Environmental Review Coordinator
Maine Department of Inland Fisheries and Wildlife
284 State Street, 41 SHS
Augusta, Maine 04333-0041
Tel (207) 287-5254; Cell (207) 446-5145
Fax (207) 287-6395
www.mefishwildlife.com

DOT Impacts 1/25/16

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION
16 STATE HOUSE STATION
AUGUSTA, MAINE 04333-0016

Paul R. LePage
GOVERNOR

David Bernhardt
COMMISSIONER

To: Michael T. Parker, MaineDEP

From: Stephen Landry, PE State Traffic Engineer MaineDOT

cc: [Name]

Date: December 28, 2015

Re: Juniper Ridge Landfill, Old Town, ME

Michael,

In reviewing the information sent by on the traffic impacts of the landfill facility, I have found that an increase of 3 trips in the peak hour have minimal impacts on the roadway given the current background traffic levels. In reviewing Gorrill Palmers submittal on traffic, I can conclude that at the background levels, 1 extra trip every 20 minutes will not move the impact level enough to warrant any additional roadway mitigation. There are no high crash locations in the vicinity of this development so they will not be exacerbating any existing problem areas. The proposed volumes are still under those originally permitted for the site.

I have reviewed the existing routes and find that there are no issues from the existing hauling along the route. From what I have reviewed, I don't see any negative impacts to traffic with the expansion.

STATE OF MAINE
STEPHEN R. LANDRY
No. 7930
LICENSED
PROFESSIONAL ENGINEER

Parker, Michael T Good Standing comment 1/25/16

From: Christopher Roney <croney@famemaine.com>
Sent: Wednesday, January 06, 2016 3:11 PM
To: Parker, Michael T
Cc: Bill Norbert; Bruce Wagner
Subject: RE: Casella Waste Systems, Inc.

This message was sent securely using ZixCorp.

Hello Michael.

All of the bonds you reference are non-recourse (to FAME) bonds, meaning that FAME has no financial exposure. The Company pays the bondholders directly or through a Trustee, and in either case FAME does not actively monitor payment compliance, since it bears no risk in the event of a default. That being said, we would likely know of a payment default and we currently have no knowledge of any payment defaults. I can report that as for any obligations that the Company has directly to FAME, rather than the Bondholders, we consider them to be in good standing.

I hope this is helpful. Let me know if you need additional information.

Chris Roney

Christopher Roney
General Counsel
FINANCE AUTHORITY OF MAINE
P.O. Box 949, 5 Community Drive, Augusta, ME 04332-0949
207-620- 3520 or 1-800-228-3734
Fax: 207-213-2620 – TTY: 207-626-2717
croney@famemaine.com

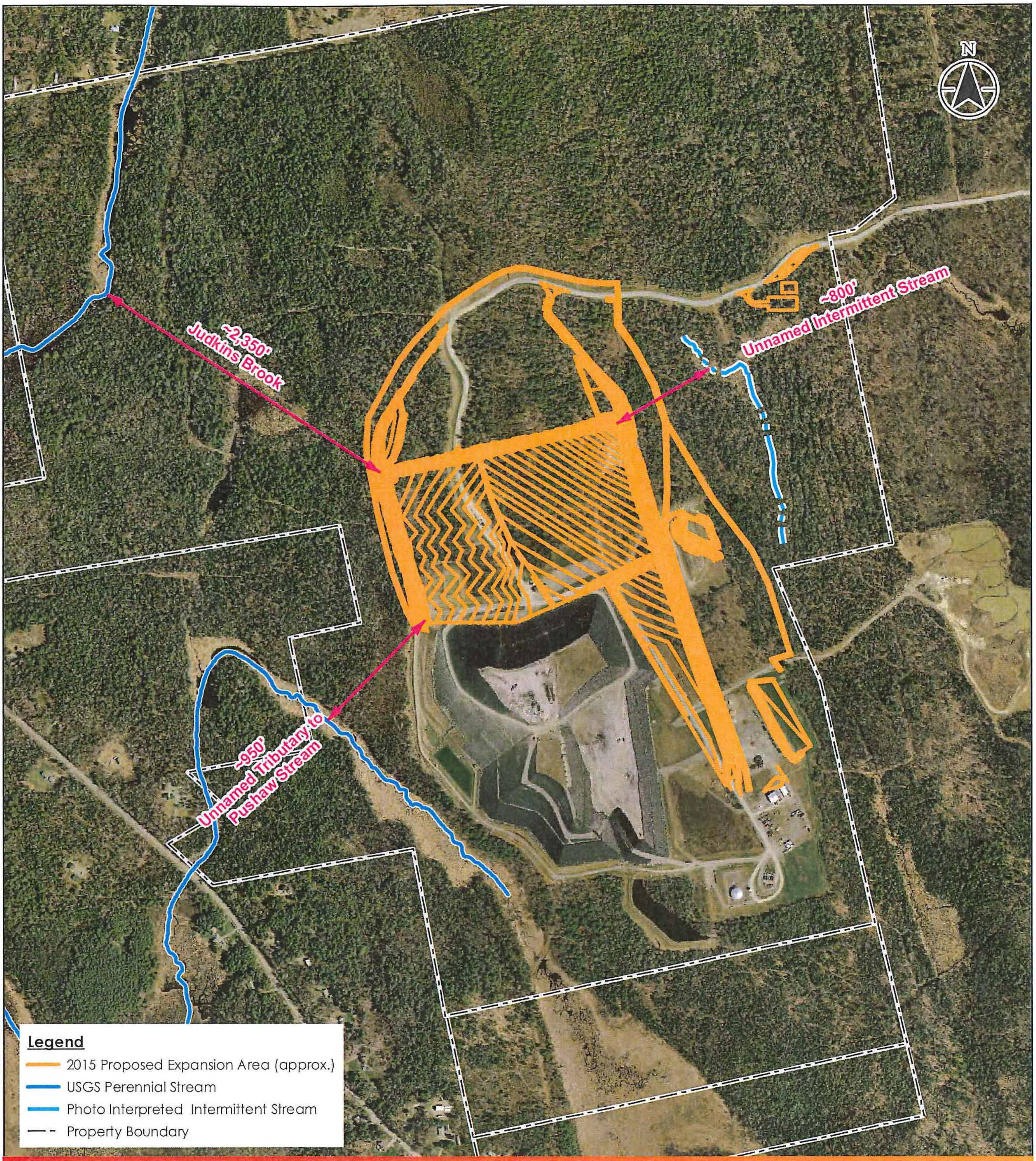
Helping Maine people achieve their business and education goals since 1983
Best Places to Work in Maine - 2015
Web | Facebook | Twitter

From: Parker, Michael T [mailto:Michael.T.Parker@maine.gov]
Sent: Wednesday, January 06, 2016 1:32 PM
To: Christopher Roney
Subject: Casella Waste Systems, Inc.

Hi, Christopher.

I am writing to inquire about a few bonds issued to Casella Waste Systems, Inc. by FAME. In the company's last 10-K filing (2014) they list two bonds, 2005R-1 and 2005R-2, with outstanding principals of $3.6 million and $21.4 million, respectively. In addition, my research shows the company was issued a Solid Waste Disposal Revenue Bond Series 2015 for $15 million. My question is what is the status of the company's account; is it in good standing, are the payments up to date? I ask in the context of a licensing proceeding currently before the DEP involving this company. One of the

BGS/NEWSME 58



195600983

Stantec

30 Park Drive
Topsham, ME USA 04086
Phone (207) 729-1199

Revised by KWH on 2016-08-18
Reviewed by BPE on 2016-08-18

00983_00_StreamBuffers_8.5x11.mxd

0 1,000 Feet

1 inch = 1,000 feet (At page size of 8.5"x11")

Notes

1. Refer to Figure 1 of the Juniper Ridge Landfill Expansion Project: Wetland and Waterbody Delineation and Vernal Pool Survey Report, produced by Stantec.
2. Coordinate System: NAD 1983 StatePlane Maine East FIPS 1801 Feet
3. Orthophotography from 2013 provided by Maine Office of GIS.

Client/Project

NEWSME Landfill Operations LLC
Juniper Ridge Landfill Expansion
Old Town, Maine

Figure No.

1

Title

Stream Buffers

8/29/2016

Wetland and Stream Buffer Size Requirements—A Review

A. J. Castelle,* A. W. Johnson, and C. Conolly

ABSTRACT

Upland vegetated buffers are widely regarded as being necessary to protect wetlands, streams, and other aquatic resources. Buffer size requirements, however, have typically been established by political acceptability, not scientific merit. This often leads to insufficiently buffered aquatic resources. In order to assist public agencies in formulating appropriate buffer standards, we conducted a literature search of the scientific functions of buffers. The literature search reconfirmed the need for buffers and emphasized the importance of considering specific buffer functions. A range of buffer widths from 3 m to 200 m was found to be effective, depending on site-specific conditions; a buffer of at least 15 m was found to be necessary to protect wetlands and streams under most conditions.

Aquatic resources such as wetlands and streams are subject to disturbances that originate in adjacent upland areas. These disturbances can result in changes in the biological, chemical, and physical properties of wetlands and streams. As a result of external influences, aquatic resources may be exposed to higher levels of noise, light, temperature, pollutant loading, stormwater runoff, invasive species establishment, and human activity. These disruptions often lead to a reduction in wetland and stream functional value.

A common method for reducing or eliminating impacts to aquatic resources from adjacent land uses is to maintain buffers around the resources. *Buffers* are vegetated zones located between natural resources and adjacent areas subject to human alteration. In some locations, a buffer may be referred to as a *vegetated filter strip.* The emphasis on the filtering functions of buffers is derived from their widespread use to remove sediments and other waterborne pollutants from surface runoff.

There is rarely debate regarding the need for some buffering of valuable aquatic resources from potential anthropogenic degradation. However, there is often little agreement regarding the degree of buffering necessary or how best to achieve that measure of protection. One of the important factors which determines the effectiveness of a buffer is its size. Buffers that are undersized may place aquatic resources at risk; however, buffers that are larger than needed may unnecessarily deny landowners the use of a portion of their land. Therefore, it is important to be able to determine the minimum buffer width necessary for aquatic resource protection.

Resource agencies are most often responsible for setting buffer requirements. Many agencies seek to attain *no net loss* of wetlands. However, wetland buffer policies have often been established with significant regard for political acceptability but with little consideration of scientific data. As a result, many people are unable to recognize that the resources may be at serious risk because of the false perception that the resources are being properly buffered from potential impacts.

In order to balance development with effective natural resource protection, a rational strategy for protecting aquatic resources must be developed. It appears that the use of buffers will continue to be an important element of this strategy. To accomplish this, scientifically based criteria for establishing buffer requirements must be utilized by resource agencies.

In this paper, we address the status of wetland and stream buffers to provide a basis for establishing wetland buffer requirements that are scientifically sound. Much of the information presented here was obtained during the completion of recent studies sponsored by the Washington State Department of Ecology and King County (Washington) Surface Water Management Division. The former study focused on wetland buffers (Castelle et al., 1992a,b); the latter study concentrated on stream buffers (Johnson and Ryba, 1992).

For purposes of this paper, buffers consist of either native vegetation, which is left undisturbed, or may be areas that were wholly or partially cleared and then subsequently revegetated. Further, we focused on buffers intended to reduce or eliminate potential damage to wetlands and streams from anthropogenic sources. We realize, however, that other natural resources are also threatened by human activities and are similarly in need of protection. Additionally, we have not specifically addressed potential adverse impacts to aquatic resources due to natural processes (for example, slope failures and floods); however, we recognize that in many instances aquatic resources are protected from such occurrences by surrounding uplands.

DISCUSSION

Four criteria have been identified for determining adequate buffer sizes for aquatic resources: (i) resource functional value, (ii) intensity of adjacent land use, (iii) buffer characteristics, and (iv) specific buffer functions required (Castelle et al., 1992a). Generally, smaller buffers are adequate when the buffer is in good condition (e.g., dense native vegetation, undisturbed soils), the wetland or stream is of relatively low functional value (e.g., high disturbance regime, dominated by nonnative plants), and the adjacent land use has low impact potential (e.g., park land, low density residences). Larger buffers are necessary for high value wetlands and streams that are buffered from intense adjacent land uses by buffers in poor condition.

Many agencies throughout the USA rely primarily on a combination of political acceptability and assumed aquatic resource functional value to establish buffer stan-

A.J. Castelle and C. Conolly, Adolfson Associates, 5309 Shilshole Ave. N.W., Seattle, WA 98107; and A.W. Johnson, Aquatic Resource Consultants, 1606 Nob Hill Ave. N., Seattle, WA 98109. Received 16 Feb. 1993. *Corresponding author.

Published in J. Environ. Qual. 23:878–882 (1994).

Abbreviations: VFSs, vegetated filter strips; HSI, habitat suitability index; DHD, direct human disturbance.

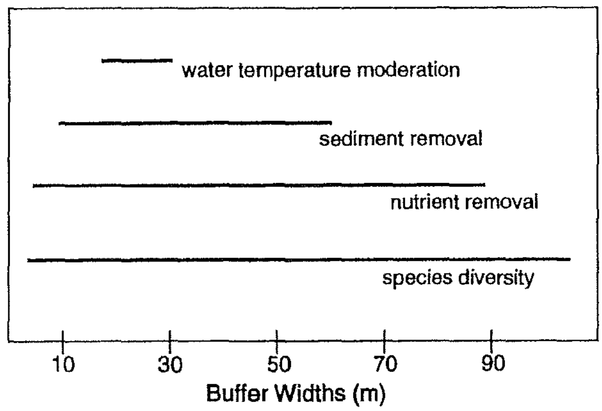


Fig. 1. Range of buffer widths for providing specific buffer functions.

dards (Castelle et al., 1992a). A search of the literature suggests, however, that a scientific approach would depend on the specific functions that a buffer needs to provide under site-specific conditions. Accordingly, this discussion presents the findings of the literature, focusing on specific buffer functions.

Buffer Size Requirements

Buffer widths necessary for adequate performance of several specific buffer functions—based upon their biological, chemical, and physical characteristics—are given in Fig. 1. The results illustrate that buffer sizes may vary widely, depending on the specific functions required for a particular buffer. The following presents an overview of some important buffer functions and the buffer widths necessary to achieve those functions. Note that in addition to SI units given for buffer sizes, English units are included in parentheses. The alternative units are included because these are the units typically used by regulatory and resource agencies in the USA.

Sediment Removal and Erosion Control. Vegetated buffers control erosion by blocking the flow of sediment and debris, by stabilizing streambanks and wetland edges, and by promoting infiltration (Shisler et al., 1987). Buffer vegetation forms a physical barrier that slows surface flow rates and mechanically traps sediment and debris. Roots maintain soil structure and physically restrain otherwise erodible soil. Flow rates are generally lower for sheetflow than for channelized flow. Therefore, where vegetation helps resist the formation of channels, water will flow more slowly, allowing more time for settling of sediments and infiltration.

Wong and McCuen (1982) derived an equation to determine effective buffer widths, based upon sediment particle size, slope, surface roughness, and runoff characteristics. While small buffers were found to remove small amounts of sediments, the relationship between buffer width and percent sediment removal was nonlinear. Disproportionately large buffer widths were required for incrementally greater sediment removal. For example, if the sediment removal design criteria were increased from 90 to 95% on a 2% slope, then the buffer widths would have to be doubled from 30.5 to 61 m (100–200 ft).

Young et al. (1980) found that a 24.4 m (80 ft) vegetated buffer reduced the suspended sediment in the feedlot runoff by 92%, but Schellinger and Clausen (1992) determined that a 22.9-m (75-ft) *filter strip* removed just 33% of the suspended solids from dairy farm runoff. Horner and Mar (1982) reported that a 61-m (200-ft) grassy swale removed 80% of the suspended solids and total recoverable Pb; Broderson (1973) also found buffers that are 61 m wide to effectively control sedimentation, even on steep slopes. According to Lynch et al. (1985), a 30-m (98-ft) buffer between logging activity and wetlands and streams removed an average of approximately 75 to 80% of the suspended sediment in stormwater. Greater sedimentation resulted from forested areas that had been commercially clear-cut and then denuded with an herbicide because of channelization, which developed following these activities. Ghaffarzadeh et al. (1992) examined sediment removal by grass vegetated filter strips (VFSs) ranging from 0 to 18.3 m (60 ft) on 7 and 12% slopes. They found no difference in VFS performance on either slope beyond 9.1 m, where 85% of the sediment was removed. Further, there was no difference in sediment removal between the two slope angles beyond 3.1 m.

Excess Nutrient and Metal Removal. Buffers can remove metals and excess nutrients from runoff by both filtering water and via plant uptake. Madison et al. (1992) examined the ability of grass VFSs to reduce NH_4–N, NO_3–N, and PO_4–P from two simulated storm events (the equivalents of the 1-yr and 10-yr events). Reporting the results as *trapping efficiencies*, they found that a 4.6 m (15 ft) VFS trapped approximately 90% of each of these nutrients. Grassy VFSs which were 9.1 m (30 ft) wide had trapping efficiencies of between 96 and 99.9%. Vegetated filter strips wider than 9.1 m did not result in further improved trapping efficiencies. Earlier, Dillaha et al. (1989) reported that 9.1 and 4.6 m VFSs removed an average of 84 and 70% of suspended solids, 79 and 61% of P, and 73 and 54% of N, respectively. Xu et al. (1992) found that NO_3 concentrations were reduced from 764 mg NO_3–N kg^{-1} soil to approximately 0.5 mg NO_3–N kg^{-1} soil in a 10-m mixed herbaceous and forested buffer strip in the North Carolina Piedmont.

Murdock and Capobianco (1979) found that mannagrass (*Glyceria grandis*) took up 80% of the available P, and also took up significant quantities of Pb, Zn, and Cr. Gallagher and Kibbey (1980) found that other species accumulated Cu, Cr, Fe, Mn, Sr, Pb, and Zn. Hubbard and Lowrance (1992) noted the NO_3 had "very little impact" on riparian systems after passing through a 7-m (23.2-ft) forested buffer. They attributed the loss of NO_3 in the buffer to a combination of microbial denitrification and plant uptake.

Vanderholm and Dickey (1978) monitored feedlots and found buffer widths ranging from 91.5 m (300 ft) at 0.5% slope to 262.2 m (860 ft) at 4.0% slope to be effective in removing 80% of the nutrients, of the solids, and of the biological oxygen demand from surface runoff through sediment removal and nutrient uptake. Doyle et al. (1977) found that 3.8 m (12.5 ft) forested buffers and 4.0 m (13.1 ft) grass buffers reduced N, P, K, and fecal bacteria levels. Lynch et al. (1985) evaluated the ability of vegetated buffers in reducing soluble nutrient levels in runoff from logging operations. They found that a 30-m (98 ft) buffer reduced nutrient levels in the water to "far below drinking water standards."

A slightly different approach was used by Bingham et al. (1980), who studied pollutant runoff from caged poultry manure. Rather than recommending specific buffer widths, the authors reported that a 1:1 ratio of buffer area to waste area (the cumulative surface area of the poultry cages) was successful in reducing nutrient runoff to background levels for animal waste practices. Overcash et al. (1981) analyzed grass buffer strips as vegetative filters for nonpoint-source pollution from animal waste with a one dimensional model, and also concluded that a 1:1 ratio was sufficient to reduce animal waste concentrations by 90 to 100%. Wooded riparian buffers in the Maryland coastal region were found to remove as much as 80% of excess P and 89% of excess N, most of it in the first 19 m (62.3 ft) (Shisler et al., 1987).

Moderation of Stormwater Runoff. Wetland and stream buffers affect the quantity as well as the quality of stormwater runoff. A vegetated buffer zone that resists channelization is effective in decreasing the rate of water flow, and in turn, increasing the rate of infiltration (Broderson, 1973). Bertulli (1981) concluded that adjacent forest vegetation and litter lowered stream water elevations from 9.9 m (32.3 ft) to 5.3 m (17.3 ft) for a 100-yr flood.

Moderation of Water Temperature. Forested buffers adjacent to wetlands provide cover, thereby helping to maintain lower water temperatures in summer and lessen temperature decreases in winter. Broderson (1973) found that 15.2-m (50-ft) buffers provided adequate shade for small streams; further, buffer widths along slopes could decrease with increasing tree height with no significant loss of shading.

Lynch et al. (1985) determined that a 30-m (98-ft) buffer from logging operations maintained water temperatures within 1°C of their former average temperature. Barton et al. (1985) found a strong correlation between maximum water temperatures and buffer length and width for trout streams in southern Ontario, Canada. They derived a regression equation in which buffer dimensions accounted for 90% of the observed temperature variation.

In their study, Brazier and Brown (1973) sought to define the characteristics of buffer strips that were important in shading small streams adjacent to logging. They found that 24 m (73 ft) forested buffer was often sufficient to shade these streams, maintaining prelogging temperature ranges. Buffers that are at least 30 m wide have generally been found to provide the same level of shading as that of an old-growth forest (Beschta et al., 1987).

Maintenance of Habitat Diversity. Some wetland-dependent birds and animals have specific needs that can only be met in the adjacent upland buffer (Naiman et al., 1988). Species such as wood ducks, great blue herons, pileated woodpeckers, and ospreys require large trees for nesting. Amphibians such as the pacific tree frog spend only a short portion of their life span in a wetland, although they cannot complete their life cycle without one. This is often true of small wetland-dependent mammals as well (Castelle et al., 1992a), because these animals must burrow above the water table to avoid inundation of their burrows.

Isolated wetlands, riparian corridors, and their buffers often afford most of the green space in urban environments. These green spaces allow animals and birds to travel through the urban landscape with some protection from humans and domestic animals in *wildlife corridors*.

Buffers may also form a transition zone between upland and aquatic environments. The ecotone, or area where one ecotype touches another, is recognized as a boundary having a set of characteristics uniquely defined by space and time scales, and by the strength of the interaction between the adjacent ecological systems (Naiman et al., 1988). *Edge effect* theory proposes that species numbers of both plants and animals increase at edges, due to overlap from adjacent habitats and to creation of unique edge-habitat niches.

Wildlife Species Distribution and Diversity. Milligan (1985) studied bird species distribution in 23 urban wetlands in King County, Washington. Bird species diversity, richness, relative abundance, and breeding numbers were positively correlated with wetland buffer size. Hickman and Raleigh (1982) studied cutthroat trout, and recommended that 30.5 m (100 ft) buffers be employed, although no data were presented to support this recommendation. Moring (1982) assessed the effect of sedimentation following logging with and without buffer strips of 30 m (98 ft) and found that increased sedimentation from logged, unbuffered stream banks clogged gravel streambeds and interfered with salmonid egg development. With buffer strips of 30 m or greater, salmonid eggs and alevins developed normally. Erman et al. (1977) also found that a 30-m buffer zone was successful in maintaining background levels of benthic invertebrates in streams adjacent to logging activity in a study of California streams.

Finally, a series of habitat suitability index (HSI) models has been published by the U.S. Fish and Wildlife Service for a variety of wildlife species, including birds, mammals, reptiles, and amphibians (e.g., Raleigh, 1982; McMahon, 1983; Sousa and Farmer, 1983; Raleigh et al., 1984; Schroeder, 1984). Space limitations do not permit a proper review of studies based on HSI models in this paper. In summary, however, these studies have demonstrated a need for buffer widths of between 3.0 and 106.7 m (10 and 350 ft), depending on the particular resource needs of individual species.

Reduction of Human Impact. Buffers protect wetlands from direct human impact through limiting easy access to the wetland and by blocking or attenuating the conveyance of noise, light, odors, and debris. Shisler et al. (1987) analyzed 100 sites in coastal New Jersey to evaluate the relationship between buffer width and direct human disturbance (DHD) to wetlands. These authors found that the adjacent land use type accounted for much of the variation found in the level of human disturbance. In all cases, human disturbance was higher in wetlands adjacent to dense residential, commercial, or industrial uses. They also found that there was an inverse relationship between buffer width and DHD.

Harris (1985) studied noise attenuation (expressed as *insertion loss*) through vegetated borders along busy streets. This report concluded that the insertion loss through an evergreen vegetated buffer was between 0.7 and 1.0 db (A) per m. Therefore, a mature evergreen buffer 6.1 m (20 ft) wide would provide an insertion loss of approximately 4 to 6 db (A) per m. Without such a buffer, tripling the distance between the noise source and the receptor would be necessary to achieve an insertion loss of this magnitude. Groffman et al. (1990) recommended a heavily forested buffer of 32 m (100 ft) to reduce the noise of commercial areas to background levels.

Agency Applicability

Many regulatory agencies rely predominantly on wetland and stream rating systems (a measure of functional value) to establish buffer sizes (Castelle et al., 1992a). For example, in Washington State, the Washington Department of Ecology has developed a four-tiered wetlands rating system (Washington Dep. of Ecol., 1991) and King County has established a three-tiered rating system for both wetlands and streams (King County Sensitive Areas Ord., 1990). In each case, larger buffers are required around higher rated aquatic resources than around resources of lower relative value. While the Washington Department of Ecology system also considers the intensity of adjacent land use in establishing wetland buffers (Washington Dep. of Ecol., 1991), most other agencies apply a single buffer size requirement regardless of site-specific conditions (Castelle et al., 1992a).

Even in the Washington State example given, however, several important criteria identified in the literature have been omitted from consideration during buffer size establishment. First, despite the number of studies that have identified effective buffer widths for specific buffer functions, no buffer size regulations were identified that considered individual buffer functions (Castelle et al., 1992a). Secondly, buffer characteristics or conditions have seldom been addressed in current regulations. By considering only aquatic resource functional value in developing buffer requirements, agencies are utilizing only one of four of the criteria identified for establishing buffer sizes. Additionally, by not considering individual buffer functions, most of the scientific information available regarding buffers is ignored.

Given that agencies typically do not consider all of the criteria, and that buffer widths are most often based on functional value alone (and perhaps, more commonly, on political acceptability), it may be helpful to identify general guidelines for buffer sizes. Buffer size requirements may fall under one of two categories: fixed-width and variable-width. Each of these types of buffer requirements has advantages and disadvantages. Fixed-width buffers are most often based on a single parameter, such as functional value. Fixed-width buffers are more easily enforced, do not require regulatory personnel with specialized knowledge of ecological principles, allow for greater regulatory predictability, and require smaller expenditures of both time and money to administer. However, fixed-width buffer systems most often do not consider site-specific conditions, and therefore may not adequately buffer aquatic resources. Variable-width buffers are generally based on a combination of buffer sizing criteria, such as functional value and adjacent land use intensity. Variable-width buffer requirements consider site-specific conditions and may be adjusted accordingly to adequately protect valuable resources. Unfortunately, variable-width buffers also require a greater expenditure of resources and a higher level of training for agency staff, while offering less predictability for land use planning.

From the literature, it appears that buffers less than 5 to 10 m provide little protection of aquatic resources under most conditions. Based on existing literature, buffers necessary to protect wetlands and streams should be a minimum of 15 to 30 m in width under most circumstances. Generally, minimum buffer widths toward the lower end of this range may provide for the maintenance of the natural physical and chemical characteristics of aquatic resources. Buffer widths toward the upper end of this range appear to be the minimum necessary for maintenance of the biological components of many wetlands and streams. Note, however, that site-specific conditions may indicate the need for substantially larger buffers or for somewhat smaller buffers.

REFERENCES

Barton, D.R., W.D. Taylor, and R.M. Biette. 1985. Dimensions of riparian buffer strips required to maintain trout habitat in southern Ontario streams. North Am. J. Fish. Manage. 5:364–378.

Bertulli, J.A. 1981. Influence of a forested wetland on a southern Ontario watershed. p. 33–47. *In* Proc. of the Ontario Wetlands Conference. Federation of Ontario Naturalists and Dep. of Applied Geography, Ryerson Polytechnical Inst., Toronto, ON.

Beschta, R.L., R.E. Bilby, G.W. Brown, L.B. Holtby, and T.D. Hofstra. 1987. Stream temperature and aquatic habitat: Fisheries and forestry interactions. p. 191–232. *In* E.O. Salo and T.W. Cundy (ed.) Streamside management: Forestry and fishery interactions. Contrib. 57. Seattle, WA. February 1986. Inst. of For. Res., Univ. of Washington, Seattle, WA.

Bingham, S.C., P.W. Westerman, and M.R. Overcash. 1980. Effects of grass buffer zone length in reducing the pollution from land application areas. Trans. ASAE 23:330–342.

Brazier, J.R., and G.W. Brown. 1973. Buffer strips for stream temperature control. Res. Pap. 15. Forest Research Lab, Oregon State Univ., Corvallis, OR.

Broderson, J.M. 1973. Sizing buffer strips to maintain water quality. M.S. thesis. Univ. of Washington, Seattle, WA.

Castelle, A.J., C. Conolly, M. Emers, E.D. Metz, S. Meyer, M. Witter, S. Mauermann, T. Erickson, and S.S. Cooke. 1992a. Wetland buffers: Use and effectiveness. Publ. 92-10. Adolfson Assoc., for Shorelands and Coastal Zone Manage. Program, Washington Dep. of Ecology, Olympia, WA.

Castelle, A.J., C. Conolly, M. Emers, E.D. Metz, S. Meyer, and M. Witter. 1992b. Wetland buffers: An annotated bibliography. Publ. 92-11. Adolfson Assoc., for Shorelands and Coastal Zone Manage. Program, Washington Dep. of Ecology, Olympia, WA.

Dillaha, T.A., R.B. Reneau, S. Mostaghimi, and D. Lee. 1989. Vegetative filter strips for agricultural nonpoint source pollution control. Trans. ASAE 32:513–519.

Doyle, R.C., G.C. Stanton, and D.C. Wolf. 1977. Effectiveness of forest and grass buffer strips in improving the water quality of manure polluted runoff. ASAE, Pap. 77-2501. ASAE, St. Joseph,

MI.
Erman, D.C., J.D. Newbold, and K.B. Roby. 1977. Evaluation of streamside bufferstrips for protecting aquatic organisms. Tech. Completion Rep., Contrib. 165. California Water Resour. Center, Univ. of California-Davis, Davis, CA.
Gallagher, J.L., and H.V. Kibbey. 1980. Marsh plants as vectors in trace metal transport in Oregon tidal marshes. Am. J. Bot. 67: 1069–1074.
Ghaffarzadeh, M., C.A. Robinson, and R.M. Cruse. 1992. Vegetative filter strip effects on sediment deposition from overland flow. p. 324. *In* Agronomy abstracts. ASA, Madison, WI.
Groffman, P.M., A.J. Gold, T.P. Husband, R.C. Simmons, and W.R. Eddleman. 1990. An investigation into multiple uses of vegetated buffer strips. Publ. NBP-90-44. Dep. of Nat. Res. Sci., Univ. of Rhode Island, Kingston, RI.
Harris, R.A. 1985. Vegetative barriers: An alternative highway noise abatement measure. Noise Control Eng. J. 27:4–8.
Hickman, T., and R.F. Raleigh. 1982. Habitat suitability index models: Cutthroat trout. FWS/OBS-82/10.5. U.S. Dep. of the Interior, Fish and Wildlife Service, Washington, DC.
Horner, R.R., and B.W. Mar. 1982. Guide for water quality impact assessment of highway operations and maintenance. Rep. WA-RD-39.14. Washington Dep. of Trans., Olympia, WA.
Hubbard, R.K., and R.R. Lowrance. 1992. Solute transport through a riparian forest buffer system. p. 43–44. *In* Agronomy abstracts. ASA, Madison, WI.
Johnson, A.W., and D. Ryba. 1992. A literature review of recommended buffer widths to maintain various functions of stream riparian areas. King County Surface Water Manage. Div., Seattle, WA.
King County Sensitive Areas Ordinance. 1990. King County (Washington) Ordinance no. 9614, King County, WA.
Lynch, J.A., E.S. Corbett, and K. Mussallem. 1985. Best management practices for controlling nonpoint-source pollution on forested watersheds. J. Soil Water Conserv. 40:164–167.
Madison, C.E., R.L. Blevins, W.W. Frye, and B.J. Barfield. 1992. Tillage and grass filter strip effects upon sediment and chemical losses. p. 331. *In* Agronomy abstracts. ASA, Madison, WI.
McMahon, T.E. 1983. Habitat suitability index models: Coho salmon. FWS/OBS-82/10.49. U.S. Dep. of the Interior, Fish and Wildlife Service, Washington, DC.
Milligan, D.A. 1985. The ecology of avian use of urban freshwater wetlands in King County, Washington. M.S. thesis. Univ. of Washington, Seattle, WA.
Moring, J.R. 1982. Decrease in stream gravel permeability after clear-cut logging: An indication of intragravel conditions for developing salmonid eggs and alevins. Hydrobiologia 88:295–298.
Murdock, A., and J.A. Capobianco. 1979. Effluent on a natural marsh. J. Water Pollut. Control Fed. 51:2243–2256.
Naiman, R.J., H. Decamps, J. Pastor, and C.A. Johnston. 1988. The potential importance of boundaries to fluvial ecosystems. J. North Am. Benthological Soc. 7:289–306.
Overcash, M.R., S.C. Bingham, and P.W. Westerman. 1981. Predicting runoff pollutant reduction in buffer zones adjacent to land treatment sites. Trans. ASAE 24:430–435.
Raleigh, R.F. 1982. Habitat suitability index models: Brook trout. FWS/OBS-82/10.24. U.S. Dep. of the Interior, Fish and Wildlife Service, Washington, DC.
Raleigh, R.F., T. Hickman, R.C. Solomon, and P.C. Nelson. 1984. Habitat suitability information: Rainbow trout. FWS/OBS-82/10.60. U.S. Dep. of the Interior, Fish and Wildlife Service, Washington, DC.
Schellinger, G.R., and J.C. Clausen. 1992. Vegetative filter treatment of dairy barnyard runoff in cold regions. J. Environ. Qual. 21: 40–45.
Schroeder, R.L. 1984. Habitat suitability index models: Black brant. FWS/OBS-82/10.63. U.S. Dep. of the Interior, Fish and Wildlife Service, Washington, DC.
Shisler, J.K., R.A. Jordan, and R.N. Wargo. 1987. Coastal wetland buffer delineation. New Jersey Dep. of Environ. Protection, Div. of Coastal Resources, Trenton, NJ.
Sousa, P.J., and A.H. Farmer. 1983. Habitat suitability index models: Wood duck. FWS/OBS-82/10.43. U.S. Dep. of the Interior, Fish and Wildlife Service, Washington, DC.
Vanderholm, D.H., and E.C. Dickey. 1978. ASAE Pap. 78-2570. ASAE Winter Meeting, Chicago, IL. ASAE, St. Joseph, MI.
Washington Department of Ecology. 1991. Washington State Wetlands Rating System. Wash. Dep. of Ecology, Olympia, Pub. No. 91-57.
Wong, S.L., and R.H. McCuen. 1982. The design of vegetative buffer strips for runoff and sediment control. A tech. pap. developed as part of a study of stormwater management in coastal areas funded by Maryland Coastal Zone Management Program. Civ. Eng. Dep., Univ. of Maryland, College Park, MD.
Xu, L., J.W. Gilliam, and R.B. Daniels. 1992. Nitrate movement and loss in riparian buffer areas. p. 342. *In* Agronomy abstracts. ASA, Madison, WI.
Young, R.A., T. Huntrods, and W. Anderson. 1980. Effectiveness of vegetated buffer strips in controlling pollution from feedlot runoff. J. Environ. Qual. 9:483–497.

BGS/NEWSME 60

The Effectiveness of Different Buffer Widths for Protecting Headwater Stream Temperature in Maine

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Abstract: We evaluated the effect of timber harvesting on summer water temperature in first-order headwater streams in western Maine. Fifteen streams were assigned to one of five treatments: (1) clearcutting with no stream buffer; (2) clearcutting with 11-m, partially harvested buffers, both sides; (3) clearcutting with 23-m, partially harvested buffers; (4) partial cuts with no designated buffer; and (5) unharvested controls. Over a 3-year period we measured summer water temperature hourly before and after harvesting, above and below the harvest zone. Streams without a buffer showed the greatest increase in mean weekly maximum temperatures following harvesting (1.4–4.4°C). Streams with an 11-m buffer showed minor, but not significant, increases (1.0–1.4°C). Streams with a 23-m buffer, partial-harvest treatment, and control streams showed no changes following harvest. The mean weekly maximum temperatures never exceeded the thermal stress limit for brook trout (25°C) in any treatment group. The mean daily temperature fluctuations for streams without buffers increased from 1.5°C/day to 3.8°C/day, while with 11-m buffers fluctuations increased nonsignificantly by 0.5–0.7°C/day. Water temperatures 100 m below the harvest zone in the no-buffer treatment were elevated above preharvest levels. We concluded that water temperature in small headwater streams is protected from the effects of clearcutting by an 11-m buffer (with >60% canopy retention). FOR. SCI. 52(3):221–231.

Key Words: Headwater stream, water temperature, riparian buffers, forest practices, buffer width.

SINCE PASSAGE of the United States Clean Water Act of 1972, much attention has been devoted to maintaining the ecological integrity of surface water, including a greater scrutiny of timber operations adjacent to watercourses. One forest management approach to minimize water quality impacts (e.g., temperature increases and sedimentation) has been to establish buffer zones with restrictions on timber harvest activities next to lakes, rivers, and large streams. This approach has addressed many water quality concerns associated with timber harvesting, but buffering waterways can represent a significant cost to landowners in terms of lost timber revenue.

Small headwater streams (intermittent and small first-order) often escape the regulatory mandates for riparian buffers (Sidle et al. 2000). For example, in the state of Maine, streams draining watersheds of less than 121 ha have no buffer or shade requirements under state law (Maine Department of Conservation 1999). Increasing awareness of the ecological importance of headwater streams (Richardson 2000) has raised questions about the amount and type of regulatory protection small streams should receive. Forest landowners and managers are concerned about potential regulations requiring buffers on small headwater streams because these features can be extremely common across the landscape. Headwater streams can account for 65–75% of the cumulative length of all stream and river channels in a watershed (Leopold et al. 1964), and establishing buffers on these streams would remove large portions of land from harvesting (Bren 1995), resulting in significant cost to landowners.

Studies of stream temperature after timber harvest have shown increases in summertime stream temperatures and diurnal fluctuations (Brown and Krygier 1967, Burton and Likens 1973, Lynch et al. 1984, Beschta et al. 1987, Kochenderfer and Edwards 1991, Johnson and Jones 2000, Murray et al. 2000, Jackson et al. 2001, Macdonald et al.

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2003). Elevation of water temperature is a concern for a number of reasons. Temperature is key in determining rates of metabolism, growth, decomposition, and solubility of gasses (Beitinger and Fitzpatrick 1979). Increases in temperature can result in increased decomposition rates and larger parasite populations (Brett 1956), decreased dissolved oxygen concentrations (Brown and Krygier 1967, Corbett et al. 1978), and increased metabolic rate, which causes increased oxygen consumption in biota (Cairns 1970).

Solar radiation is the dominant factor increasing stream temperatures after canopy removal (e.g., Brown and Krygier 1970, Sullivan et al. 1990). However, different studies examining canopy removal have yielded varying results and it is difficult to draw generalities. For example, in the absence of riparian buffers, temperature has been shown to increase from 3 to 4°C (Pacific Northwest, Brown and Krygier 1967, New Hampshire, Burton and Likens 1973, West Virginia, Kochenderfer and Edwards 1991) to 8°C (Washington, Caldwell et al. 1991). When buffers are retained, temperature changes are smaller. Riparian buffers between 15 and 20 m wide resulted in temperature increases of 2.0–2.6°C (Washington, Jackson et al. 2001), and buffers 20–30 m wide resulted in temperature increases between 1.0°C (Kochenderfer and Edwards 1991) and 2.5° C (Pennsylvania, Rishel et al. 1982, Pennsylvania, Lynch et al. 1984) of control watersheds.

The variability among studies can be attributed to a complex mix of factors, including the amount of shade retained within the buffers (Brown and Krygier 1970, Feller 1981, Lynch et al. 1985, Macdonald et al. 2003), site-specific attributes such as variability in stream size, depth, and water volume (Brown and Krygier 1967, Feller 1981, Lynch et al. 1985, Caldwell et al. 1991), geographic aspect (Kochenderfer and Edwards 1991, Macdonald et al. 2003), inputs of groundwater (Sullivan et al. 1990, Caldwell et al. 1991), and geographic location (latitude and elevation) (Hewlett and Fortson 1982, Caldwell et al. 1991). The purpose of our study was to examine the effectiveness of different buffer widths for protecting water temperature in small headwater streams in managed forest landscapes of western Maine. Most stream studies have no replicates within a treatment prescription, and often lack pre and posttreatment comparisons of dependent variables. Our study had multiple streams per treatment group as well as pre and posttreatment data. The objectives of our study were twofold: (1) to evaluate water temperature changes after timber harvest on streams with partially harvested buffer strips of various widths, and (2) to examine spatial temperature recovery (downstream of harvest zones).

Methods

Study Layout and Design

Western Maine is characterized by moderately rugged, forested topography with numerous streams, rivers, and lakes. Elevations of major peaks range from 900 to 1,300 m. The primary land use in the region is forestry, with large parcels of land managed primarily for timber products. The forest is typical of the Acadian Forest Region (Seymour and Hunter 1992), consisting of northern hardwood, spruce-fir, and mixed hardwood-softwood stands. Northern hardwood stands are dominated by sugar maple (*Acer saccharum* Marsh), beech (*Fagus grandifolia* Ehrh.), and white and yellow birch (*Betula papyrifera* Marsh and *Betula alleganiensis* Britton), while spruce-fir stands consist primarily of red spruce (*Picea rubens* Sarg.) and balsam fir (*Abies balsamea* [L.] Mill.). Softwood species tend to dominate along water courses.

We selected for study 15 headwater streams draining small watersheds with mature closed-canopy cover (>85%) at least 15 m tall and undisturbed by logging activity within the past >20 years. All streams were located within a 100-km radius of 45°00′00″ N, 70°20′00″ W (Figure 1). Watersheds ranged in area from 30 to 195 ha, with a mean of 82 ha. Along each stream we established 500-m study segments with the downstream end of the segment at least 20 m upstream from any human-made disturbance such as a logging road or timber harvest. Typically, the upper end of each study reach was within 500–1,000 m of the watershed divide. We marked the study reach with rebar on both sides of the stream at 100-m intervals (Figure 2) to monument the locations of temperature probe placement. Galvanized metal spikes (30 cm long) were placed every 20 m along the stream segment to monument locations for aspect, gradient, bankfull width (i.e., distance between stream banks), and canopy closure measurements.

Sampling Regime and Treatments

Data were collected simultaneously at both treatment and control sites, both before and after the treatments were applied. Pretreatment sampling in 2001 established the relationship between the treatment sites and the control sites. After sampling in the pretreatment year, 200-m by 300-m (6 ha) harvest zones were created on both sides of each stream beginning at the 100-m station and extending upstream to

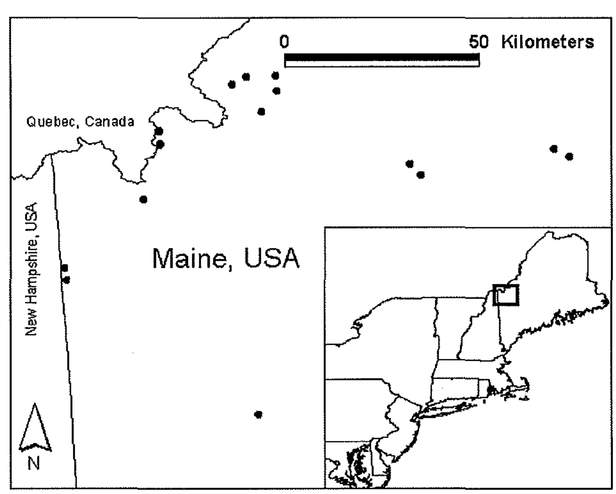

Figure 1. Map of study streams.

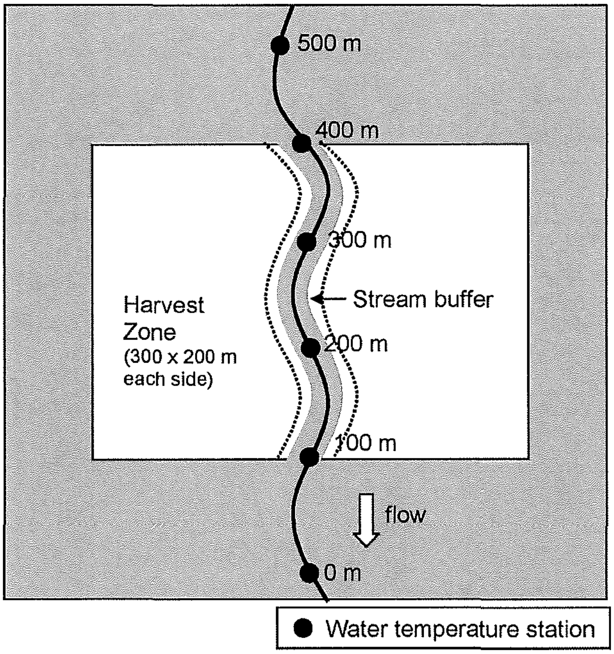

Figure 2. Layout of study segments and harvest zones.

the 400-m station (except for controls, Figure 2). There had been no recent harvesting (within the last 20 years) above the study reach within the watershed, and no harvesting was allowed upstream during the study. Forest canopy remained intact for at least 110 m below the harvest zone.

Each of the 15 study streams was randomly assigned to one of five treatment groups: (1) clearcut harvest (less than 6.8 m^2/ha residual basal area) leaving no buffer (0-m treatment); (2) clearcut harvest with 11-m buffers on both sides of the stream (11-m treatment); (3) clearcut harvest with 23-m buffers on both sides of the stream (23-m treatment); (4) selection cut harvest retaining at least 13.7 m^2/ha residual basal area in the harvest zone, without a specified buffer width (partial-harvest treatment); and (5) unharvested (control treatment). We chose a 23-m buffer for one treatment because it corresponded with existing state buffer width requirements for higher-order streams (Maine Department of Conservation 1999). To examine the capacity of a narrower buffer to protect stream temperature, we also selected an 11-m treatment (approximately one-half of 23 m). Partial harvesting was allowed in all buffers because timber removal within buffer zones is permitted and is a common practice in Maine. In this study we required at least 13.7 m^2/ha basal area to be retained (about 60% of a fully stocked stand) within the buffer zone. In all treatment groups, compaction and/or scarification of soil was not permitted within 8 m of the stream channel. Trees could be removed within 8 m of the stream channel if equipment could remove the trees without compacting or disturbing near stream soils. Harvesting occurred in the winter of 2001–2002 and posttreatment sampling occurred in 2002 and 2003.

Measurement Methods

Aspect, gradient, and bankfull width measurements were taken every 20 m along each 500-m study segment. Canopy closure above the stream channel was measured using a concave spherical densiometer before and after harvest operations (Lemmon 1957). Canopy measurements were taken in the middle of the stream channel every 20 m within the harvest zone facing upstream, downstream, left, and right with the densiometer at elbow height (~1.4 m). We assessed tree (≥8 cm dbh) basal area within the buffer and within the adjacent harvest zones using a 15-factor prism both before the harvest (2001) and after the harvest (in 2002 only). Measurements of within-buffer basal area were taken from the middle of the stream channel. Basal area measurements for the harvest zone were taken along transects originating at the stream bank edge and extending perpendicularly into the harvest zone for 200 m. Prism readings were taken every 50 m and in the same locations in 2001 (pretreatment) and 2002 (posttreatment). Study site characteristics are presented in Table 1.

Table 1. Descriptive statistics for the 15 study streams

Stream	Treatment	0-m Station elevation (m)	500-m Station elevation (m)	Watershed area (ha)	Average aspect	Average gradient (%) Mean (min, max)	Bankfull width (m) Mean (min, max)
Kibby	0 m	637	724	30	SSE	15 (4, 31)	1.9 (0.9, 4.0)
Pierce 1	0 m	469	518	52	NW	11 (3, 19)	2.5 (1.0, 6.5)
Skinner 1	0 m	616	678	41	N	12 (9, 17)	3.1 (1.3, 5.5)
Bald Mt.	11 m	345	398	96	NNW	10 (5, 17)	3.9 (2.3, 5.8)
Caratunk	11 m	408	442	80	SE	7 (0, 19)	2.8 (1.3, 6.1)
Skinner 2	11 m	619	676	37	NW	12 (12, 20)	2.0 (0.7, 4.8)
Mass 2	23 m	628	700	53	NNE	13 (3, 25)	2.6 (1.3, 5.1)
Roxbury	23 m	371	407	67	WNW	6 (2, 11)	2.4 (1.1, 3.4)
Sanderson	23 m	462	512	185	E	9 (2, 14)	3.8 (2.2, 6.5)
Mass 1	Partial	598	648	58	SSE	12 (5, 31)	2.0 (0.8, 4.9)
Pierce 2	Partial	436	529	44	W	18 (10, 31)	2.3 (1.1, 5.2)
UpCup	Partial	647	672	140	S	5 (2, 7)	4.5 (2.1, 13.2)
Appleton	Control	687	755	82	NNW	13 (6, 19)	2.8 (1.4, 4.7)
Bryant	Control	455	527	71	SW	11 (3, 16)	3.6 (2.6, 5.5)
Dud	Control	577	639	195	SW	11 (3, 17)	4.2 (2.4, 7.6)

Mean of 21 readings at 20-m intervals along each 500-m study reach.

At each of the 15 study streams, water temperature was measured hourly between June 15 and Aug. 15 of each year using automatic data loggers (OnSet Optic StowAway temperature loggers, Onset, Inc., Bourne, MA, error ±0.2°C). Clocks in all loggers were synchronized to the same launching computer on deployment. Data loggers were deployed at 100-m intervals along the 500-m study segment (see Figure 2). Loggers were placed inside 5-cm-diameter opaque PVC tubes to prevent possible influence of direct solar radiation on the logger casing. Loggers were secured by plastic cable ties to 30-cm galvanized metal spikes hammered into the streambed. For this study we only used data from loggers at the upper end of the harvest zone (400-m station), lower end of the harvest zone (100-m station), and 100 m below the harvest zone (0-m station).

During the summer in all 3 years of the study (2001–2003), portions of the 500-m study segment at many of the 15 streams began to dry, decreasing the wetted width and depth of the stream channel, sometimes completely. As a result, some water temperature data loggers became exposed to the air. Field personnel visited each stream every 1 to 3 weeks throughout the sample period. When dry data loggers were observed, if possible they were re-submerged in water as close as possible to the data logger's assigned location along the study segment. In addition, during each stream visit, the condition (wet or dry) of each probe was recorded. We eliminated from analysis any temperature data that we knew to represent, or we suspected to represent, dry conditions. If there was any question as to whether the probe was submerged, we eliminated the data from analysis. This was accomplished by using a combination of site visit data sheets and visual inspection of seasonal temperature traces to remove days with questionable data. Different streams had varying percentages of "wet days" in each year of study (Table 2), from a low of 23% wet days to a high of 100%.

Temperature Analysis

Mean weekly maximum temperature at the 100-m station was calculated for each stream to show the pre and postharvest temperature range for streams in the study. Mean weekly maximum temperature is a 7-day average of daily maximum stream temperature and is often used in stream temperature studies because it is a more biologically meaningful metric than average daily temperature (Oliver and Fidler 2001) or daily maximum temperature (Washington Water Quality Program 2002).

For each treatment, we were interested in two primary questions: (1) how does temperature change within the harvest zone, and (2) if temperature changes, does it recover 100 m downstream of the harvest zone? To answer these questions we analyzed the following dependent variables: (1) mean maximum daily temperature difference between the 400-m and 100-m stations (i.e., the upstream and downstream boundaries of the harvest zone), (2) mean maximum daily temperature difference between the 400-m and 0-m stations (i.e., the upstream boundary of the harvest zone and 100 m below the downstream boundary of the harvest zone), and (3) mean daily temperature fluctuation (i.e., daily range) at the 100-m and 0-m station. The data set was restricted to days when the station (or multiple stations) was identified as being wet.

Statistical Analyses

Differences in the percentage of wet days (Table 2) resulted in a variability in the number of observations among streams and years for each temperature metric. To minimize this variability we calculated a seasonal mean for each temperature metric and used this mean in the statistical analysis. The statistical analysis for each dependent variable was performed on one value for each stream per year of the study. This minimized the problem of missing data on days when a station was dry. A probe deployed at the 100-m station in one stream in the 11-m treatment group (Skinner 2) malfunctioned in the first postharvest year. The number of probes used in the analysis of each temperature metric is included in the data tables.

Because measurements were taken on the same experimental units (streams) before and after the application of a

Table 2. Percentage of days during the 62-day sample window (June 15–Aug. 15) in the preharvest year (2001) and the postharvest years (2002 and 2003) for which the indicated temperature probe remained submerged

		400-m Probe			100-m Probe			0-m Probe		
Stream	Treatment	2001	2002	2003	2001	2002	2003	2001	2002	2003
Kibby	0 m	100	100	100	100	100	100	100	100	100
Pierce 1	0 m	66	39	47	73	60	100	79	89	100
Skinner 1	0 m	100	100	100	100	100	98	100	100	100
Bald Mt.	11 m	79	52	37	74	100	97	100	100	97
Caratunk	11 m	79	73	100	79	97	100	77	90	100
Skinner 2	11 m	19	87	87	100	nd	100	100	100	100
Mass 2	23 m	13	44	27	100	100	100	100	100	100
Roxbury	23 m	100	100	100	94	100	100	79	87	100
Sanderson	23 m	79	100	100	100	100	100	100	100	100
Mass 1	Partial	100	79	48	77	98	53	84	100	100
Pierce 2	Partial	79	39	34	73	55	63	82	89	100
UpCup	Partial	100	100	100	100	100	100	100	100	100
Appleton	Control	69	95	84	32	92	79	69	44	95
Bryant	Control	53	44	24	35	39	23	34	40	24
Dud	Control	100	100	100	100	100	100	100	100	100

treatment (stream buffer prescription), we used repeated-measures analysis to examine differences among treatments for the various dependent variables (PROC MIXED, SAS 1999). Treatment and Year (1 preharvest year, 2 postharvest years) were both independent variables, and Year was the repeated variable in the analysis. The interaction term between Treatment and Year indicated whether there was a differential effect of year (pre versus postharvest) on the various buffer prescriptions. Because one treatment was a control (no harvest), and because the buffer prescriptions were quite different from one another, we expected the interaction term to be significant if harvesting had an effect on any dependent temperature variable.

If the interaction term was significant, we analyzed the main effects separately (by year among treatments, and by treatment among years) to examine which treatments and years were causing changes in the response of the dependent variable. Analysis of main effects was done using Dunnett's test (treatment effect among years) and the Dunn test (year effects among treatments). The Dunnett test (Dunnett 1955) determines whether the mean of the control group differs significantly from the mean of each treatment group (Zar 1996). The Dunn test (Dunn 1961) was used to analyze for year effects among treatments. The Dunn test analyzes differences between the pretreatment and posttreatment means within each treatment group using Bonferroni adjusted multiple *t*-tests (Howell 1982).

Results

Pre and Postharvest Forest Conditions

Basal area and buffer width measurements verified that our harvest specifications for the experimental treatments were achieved by foresters and loggers (Table 3). Basal areas of harvest zones involving clearcutting (the 0-m, 11-m, and 23-m buffer treatments) were reduced an average of 95% to well below the minimum basal area (6.9 m^2/ha) of the regulatory definition of a clearcut (Table 3). The harvest zones for the partial-harvest treatment maintained average residual basal areas ranging from 14.9 to 18.9 m^2/ha, meeting our prescribed criterion of at least 13.8 m^2/ha of residual basal area. The partial-harvest treatment reduced the residual basal area of the harvest zone by an average of 38%.

The 0-m treatment harvest prescription specified no streamside canopy tree retention. The streamside basal area of this treatment group was reduced by an average of 90% (Table 3). Removal of 100% of the streamside basal area was not achieved because loggers left occasional residual trees where soil and slope conditions would have resulted in compromising the stream bank or scarifying near-stream soils. The harvest prescription for the 11-m and 23-m treatment groups specified that a minimum of 13.8 m^2/ha of residual basal area should remain in the buffer. These specifications were met in five of the six streams in the 11-m and 23-m treatment groups. One stream in the 11-m treatment group had average riparian basal area reduced to 13.5 m^2/ha, slightly below the specified level (Table 3). Within-buffer basal area was reduced by an average of 31% in the 11-m treatment group, and 21% in the 23-m treatment group.

Following the harvest, stream canopy cover was reduced an average of 77% in the 0-m treatment group (Table 3). Canopy removal was not complete on this treatment, due to occasional residual trees left by loggers (see above). Canopy closure over the stream channel was reduced an average of 11% in the 11-m treatment group, and 4% in both the 23-m and partial-harvest treatment group. Mean canopy closure in the control treatment remained unchanged (Table 3).

Mean Weekly Maximum Temperature at the 100-m Station

In the pretreatment year stream temperatures ranged from 11.9 to 15.6°C in the majority of the study streams

Table 3. Average (minimum, maximum) basal area and canopy closure for preharvest year (2001) and the first postharvest year (2002) for each of the 15 study streams

		Cut block basal area Mean (min, max) m^2/ha		Riparian buffer basal area Mean (min, max) m^2/ha		% Canopy closure Mean (min, max)	
Stream	Treatment	Preharvest 2001	Postharvest 2002	Preharvest 2001	Postharvest 2002	Preharvest 2001	Postharvest 2002
Kibby	0 m	23.9 (7.8, 46.8)	1.5 (0.0, 6.2)	30.1 (26.5, 32.7)	0.0 (0.0, 0.0)	95 (81, 99)	1 (0, 4)
Pierce 1	0 m	28.6 (6.2, 49.9)	1.3 (0.0, 12.5)	22.9 (9.4, 37.4)	3.6 (1.6, 6.2)	97 (90, 99)	37 (4, 80)
Skinner 1	0 m	25.9 (10.9, 40.0)	2.1 (0.0, 9.4)	22.3 (17.2, 28.1)	3.1 (0.0, 6.2)	95 (88, 98)	27 (2,88)
Bald Mt.	11 m	22.0 (6.2, 35.9)	0.0 (0.0, 0.0)	24.9 (15.6, 39.0)	15.1 (10.9, 18.7)	98 (86, 99)	84 (60, 93)
Caratunk	11 m	33.9 (20.3, 51.5)	1.7 (0.0, 9.4)	19.2 (10.9, 34.3)	13.5 (9.4, 18.7)	91 (53, 99)	92 (68, 98)
Skinner 2	11 m	26.0 (10.9, 39.0)	1.9 (0.0, 9.4)	21.8 (17.2, 28.1)	16.6 (0.0, 31.2)	93 (2, 99)	75 (3, 97)
Mass 2	23 m	32.7 (12.5, 54.6)	0.7 (0.0, 3.1)	29.6 (18.7, 42.1)	24.9 (15.6, 34.3)	95 (89, 98)	91 (83, 95)
Roxbury	23 m	21.8 (0.0, 34.3)	1.1 (0.0, 6.2)	21.3 (15.6, 28.1)	19.2 (15.6, 21.8)	96 (92, 99)	94 (89, 98)
Sanderson	23 m	20.4 (3.1, 42.1)	1.0 (0.0, 9.4)	24.9 (18.7, 29.6)	15.6 (9.4, 18.7)	91 (79, 98)	86 (58, 98)
Mass 1	Partial	24.3 (3.1, 48.3)	18.9 (3.1, 37.4)	17.2 (9.4, 24.9)	14.0 (6.2, 21.8)	96 (86, 99)	96 (88, 99)
Pierce 2	Partial	25.1 (12.5, 40.5)	14.9 (3.1, 37.4)	24.9 (17.2, 29.6)	16.1 (14.0, 18.7)	96 (93, 99)	91 (71, 98)
UpCup	Partial	33.8 (14.0, 59.3)	16.1 (3.1, 51.5)	22.3 (17.2, 29.6)	17.2 (12.5, 21.8)	87 (59, 98)	82 (49, 98)
Appleton	Control	22.3 (6.2, 37.4)	21.3 (6.2, 34.3)	14.6 (3.1, 21.8)	15.1 (3.1, 21.8)	93 (66, 99)	90 (68, 99)
Bryant	Control	23.1 (10.9, 32.7)	24.1 (14.0, 37.4)	19.2 (18.7, 20.3)	19.2 (15.6, 21.8)	97 (90, 99)	96 (94, 97)
Dud	Control	24.5 (12.5, 37.4)	23.8 (6.2, 34.3)	18.7 (14.0, 24.9)	19.8 (15.6, 28.1)	94 (76, 100)	92 (50, 100)

(Figure 3). One stream (Mass 2, 23-m treatment group), was much cooler, with mean weekly maximum temperatures at the 100-m station of 6.4°C. Following the harvest, temperatures increased 1.4–4.4°C in the 0-m treatment group and 1.0–1.4°C in the 11-m treatment group (Figure 3). Temperature in the 23-m, partial-harvest, and control treatment groups did not change following the harvest (Figure 3).

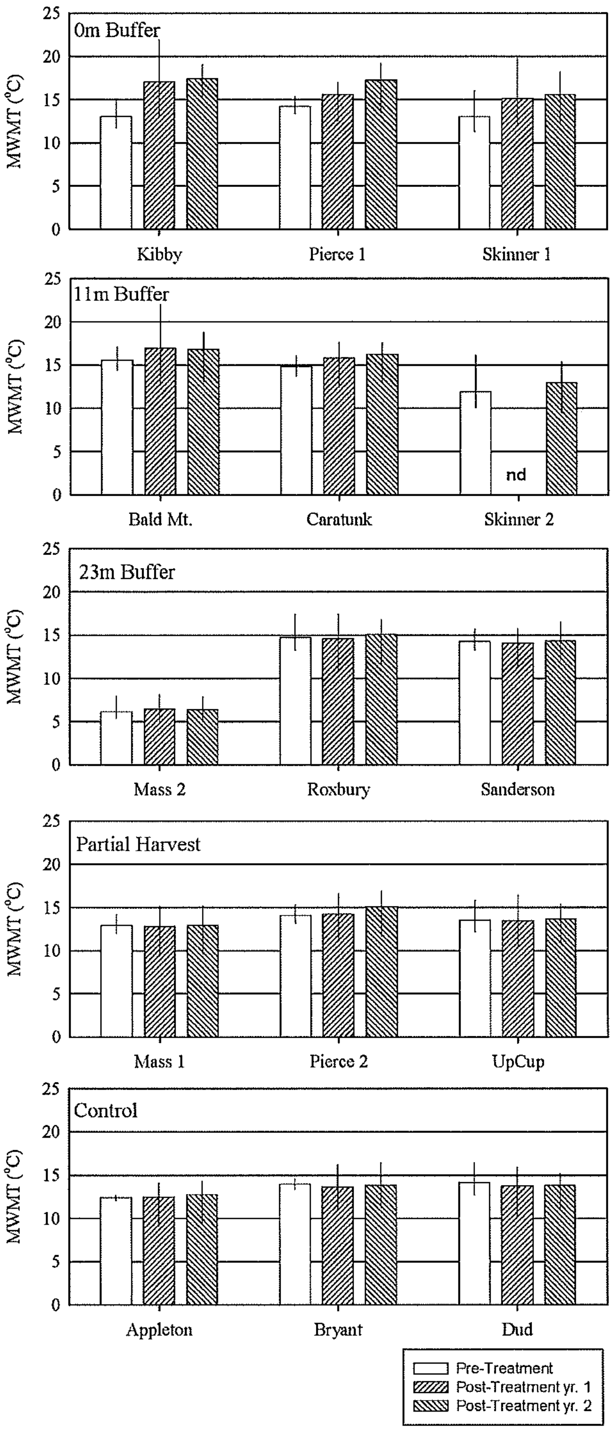

Figure 3. Mean weekly maximum stream temperature at the 100-m station from June 15 through Aug. 15 in the preharvest (2001) and postharvest (2002–2003) years. The graphical bars represent the seasonal average of weekly mean weekly maximum temperatures and the vertical lines represent the seasonal maximum and minimum weekly maximum temperatures.

Temperature Changes within the Harvest Zone: Differences between 100-m and 400-m Stations

In the preharvest year, temperature changes between the 400-m and 100-m stations were small for all treatment groups (range = −1.0°C [cooling] to +0.8°C [warming]) (Table 4). Streams exhibited both slight warming and slight cooling within the planned 300-m harvest zone. Following the harvest, temperature change within the harvest zone increased 2.5–2.8°C in the 0-m treatment group and 1.4–2.5°C in the 11-m treatment group (Table 4). No temperature changes were observed in the 23-m, partial-harvest, or control treatment group (Table 4).

Water temperature changes within the harvest zone had a significant interaction between treatment and year (P = 0.0034), indicating one or more of the harvest prescriptions affected stream temperature (the control was not expected to change). Further analysis of the main effects showed that for the 0-m treatment group water temperature changes within the harvest zone were significantly different from the control group in the first (P = 0.0032) postharvest year (Table 4, Dunnett's test). In the second postharvest year changes within the harvest zone in the 0-m treatment group were significantly greater than preharvest values (P = 0.0009) (Table 4, Dunn test). All other treatment groups (11-m, 23-m, and partial-harvest) did not significantly differ from the control group in either postharvest year nor did they show significant postharvest temperature increases within the harvest zone relative to preharvest values (Table 4).

Table 4. Mean daily maximum temperature change by treatment between the 100- and 400-m stations (lower versus upper end of the harvest zone) from June 15 to Aug. 15 in the preharvest year and two postharvest years

		100 m *vs.* 400 m Station					
		Preharvest		Postharvest			
		Year 1		Year 2		Year 3	
Treatment	n	Mean	S.E.	Mean	S.E.	Mean	S.E.
0-m	3	0.8	0.2	3.6*	0.5	**3.3**	0.4
11-m	3[1]	−1.0	1.5	1.5	0.3	0.4	1.1
23-m	3	−0.3	0.3	0.3	0.3	−0.3	0.6
Partial-cut	3	0.6	0.4	0.9	0.3	1.0	0.5
Control	3	0.6	0.3	0.7	0.3	0.6	0.2

Treatment means with an asterisk (*) are significantly different from the control treatment group based on Dunnett's test (Dunnett 1955). Treatment means in boldface type indicate significant differences from preharvest values within a treatment group based on Bonferroni adjusted multiple t-tests (Dunn 1961).

[1] n = 3 in year 1 and year 3, n = 2 in year 2 due to missing data.

Temperature Changes within the Harvest Zone: Diurnal Fluctuation

In the preharvest year, the seasonal mean diurnal fluctuations at the 100-m stations were between 1.3 and 1.9°C for all treatment groups (Table 5). Following the harvest, diurnal temperature fluctuations at the 100-m stations increased by 2.3°C in the 0-m treatment group and by 0.5–0.7°C in the 11-m treatment group (Table 5). Diurnal fluctuation did not change in the 23-m, partial-harvest, and control treatment groups (Table 5).

Statistical analysis showed a significant interaction between treatment and year ($P < 0.0001$), indicating one or more harvest prescription had an effect on diurnal fluctuation at the 100-m station. Diurnal fluctuation in the 0-m treatment group was significantly greater than the control in both the first ($P = 0.0004$) and second ($P = 0.0007$) postharvest years (Table 5, Dunnett's test). No other treatment group was significantly different from the control (Table 5). In the 0-m treatment group diurnal fluctuation at the 100-m station was significantly greater than preharvest levels in both the first ($P < 0.0001$) and second ($P < 0.0001$) postharvest years (Table 5, Dunn test). No other treatment groups showed significant changes in diurnal fluctuations relative to preharvest levels. A continuous temperature trace for a 0-m buffer stream in the pre and postharvest years graphically depicts the change in amplitude of daily temperature fluctuations at the 100-m station (Figure 4).

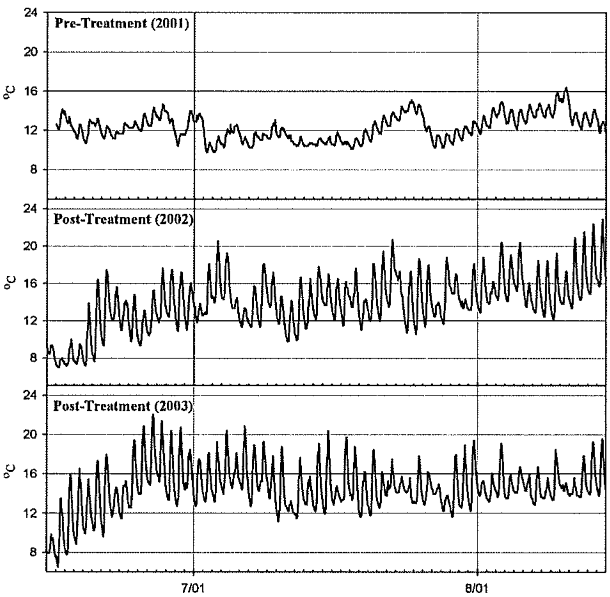

Figure 4. Hourly temperature readings at the 100-m station of a stream in the 0-m treatment group (Kibby stream) from June 15 to Aug. 15 in the preharvest (2001) and both postharvest (2002–2003) years.

Downstream Recovery: Differences between 0-m and 400-m Stations

In the preharvest year temperature changes between the 400-m and 0-m (100 m below the harvest zone) stations ranged from −1.4°C (cooling) to 0.9°C (warming). Following the harvest, temperature changes between the two stations increased 1.3–1.8°C in the 0-m treatment group and 1.1–1.3°C in the 11-m treatment group. Temperature changes between the 0-m and 400-m station had a significant interaction term ($P = 0.0045$), indicating that temperature recovery 100 m below the harvest zone was not complete for all treatment groups. Analysis of the main effects showed that no treatment group had temperature changes between the 400-m station and the 0-m station that were significantly different than the control (Table 6, Dunnett's test). However, in the 0-m treatment group temperature changes between the two stations increased over the preharvest year in the first ($P = 0.0056$) postharvest year (Table 6, Dunn test). No other treatment group had temperature changes significantly different from the preharvest levels (Table 6).

Table 5. Average maximum diurnal temperature change at the 100-m station from June 15 to Aug. 15 in the preharvest and two postharvest years

		Preharvest		Postharvest			
		Year 1		Year 2		Year 3	
Treatment	n	Mean	S.E.	Mean	S.E.	Mean	S.E.
0-m	3	1.5	0.02	**3.8***	0.8	**3.8***	0.6
11-m	3[1]	1.9	0.1	2.6	0.1	2.4	0.1
23-m	3	1.3	0.4	1.4	0.4	1.3	0.3
Partial-cut	3	1.9	0.3	2.1	0.05	1.6	0.1
Control	3	1.4	0.05	1.3	0.05	1.1	0.1

Treatment means with an asterisk (*) are significantly different from the control treatment group based on Dunnett's test (Dunnett 1955). Treatment means in boldface type indicate significant differences from preharvest values within a treatment group based on Bonferroni adjusted multiple t-tests (Dunn 1961).

[1] $n = 3$ in year 1 and year 3, $n = 2$ in year 2 due to missing data.

Table 6. Mean daily maximum temperature change by treatment between the 0- and 400-m stations (100 m downstream of the lower end of the harvest zone vs. upper end of the harvest zone) from June 15 to Aug. 15 in the preharvest year and two postharvest years

		0 vs. 400 m Station					
		Preharvest		Postharvest			
		Year 1		Year 2		Year 3	
Treatment	n	Mean	S.E.	Mean	S.E.	Mean	S.E.
0-m	3	0.7	0.5	**2.5**	0.6	2.0	0.7
11-m	3	−1.4	1.1	−0.1	0.9	−0.3	0.8
23-m	3	0.5	0.4	0.9	0.4	0.5	0.5
Partial-cut	3	0.7	0.3	1.0	0.06	0.9	0.4
Control	3	0.9	0.2	0.8	0.2	0.7	0.2

Treatment means with an asterisk (*) are significantly different from the control treatment group based on Dunnett's test (Dunnett 1955). Treatment means in boldface type indicate significant differences from preharvest values within a treatment group based on Bonferroni adjusted multiple t-tests (Dunn 1961).

Downstream Temperature Recovery: Diurnal Fluctuation

Following harvest, diurnal temperature fluctuations at the 0-m stations ranged from 2.0 to 2.5°C in the 0-m treatment group and 1.8–1.9°C in the 11-m treatment group (Table 7). These diurnal fluctuations are smaller than those observed at the 100-m stations, suggesting recovery of daily temperature fluctuations 100 m below the harvest zone. However, the interaction term between treatment and year was significant ($P = 0.0257$), indicating that recovery of diurnal fluctuations was not complete for all treatments. Analysis of the main effects showed no treatment groups had diurnal fluctuations that were significantly different from the control (Table 7, Dunnett's test). However, the diurnal fluctuations in the 0-m treatment group were significantly greater than preharvest levels in the first postharvest year ($P = 0.0316$, Table 7, Dunn test). No treatment group showed significant change in diurnal fluctuations from preharvest values in the second postharvest year (Table 7).

Discussion

Stream Temperature Changes within the Harvest Zone

This study demonstrated that leaving no buffers on small headwater streams for a 300-m harvest zone in a northern temperate forest region (~45° N latitude) resulted in postharvest increases in stream temperature. Streams in the 11-m treatment group had moderate, but statistically insignificant, increases in stream temperature while 23-m, partial-harvested, or control streams had no observable increases in temperature. Postharvest changes in stream temperatures and diurnal temperature fluctuations have been attributed primarily to increased levels of solar radiation reaching the stream channel (Brown and Krygier 1970). The extent of the increase in stream temperature following a harvest is significantly correlated with the amount of timber retained in the riparian buffer (Brown and Krygier 1970, Feller 1981, Lynch et al. 1985, Caldwell et al. 1991, Macdonald et al. 2003).

Table 7. Average maximum diurnal temperature change at the 0-m station from June 15 to Aug. 15 in the preharvest and two postharvest years

		Preharvest		Postharvest			
		Year 2		Year 2		Year 3	
Treatment	n	Mean	S.E.	Mean	S.E.	Mean	S.E.
0-m	3	1.5	0.1	**2.5**	0.6	2.0	0.4
11-m	3	1.8	0.1	1.9	0.2	1.8	0.2
23-m	3	1.8	0.3	1.6	0.4	1.5	0.4
Partial-cut	3	2.1	0.2	2.0	0.4	1.7	0.1
Control	3	1.8	0.1	1.5	0.1	1.2	0.1

Treatment means with an asterisk (*) are significantly different from the control treatment group based on Dunnett's test (Dunnett 1955). Treatment means in boldface type indicate significant differences from preharvest values within a treatment group based on Bonferroni adjusted multiple t-tests (Dunn 1961).

The 0-m treatment group had the greatest reduction in mean canopy closure (77%), and the greatest increases in mean weekly maximum temperatures, temperature change within the harvest zone, and diurnal fluctuation following the timber harvest. In the 11-m treatment group, mean canopy closure decreased by 11% as a result of the harvest. Increases in temperature were smaller than in the 0-m treatment group. The 23-m and partial-harvest treatment groups both had 4% reductions in canopy closure. These treatment groups did not exhibit postharvest changes in temperature, indicating that such a small reduction in canopy closure did not significantly alter the amount of solar radiation reaching the stream channel.

Temperature increases observed in the 0-m treatment group were smaller or in the lower end of the range of temperature increases observed by other studies on unbuffered streams. Previous studies on unbuffered streams showed average temperature increases of 3.2–5.0°C (Brown and Krygier 1967, Burton and Likens 1973, Kochenderfer and Edwards 1991) as well as increases in diurnal fluctuation between 1.7–4.2°C (Pacific Northwest, Brown and Krygier 1970) and 6.1–7.5°C (Brown and Krygier 1967) above controls or preharvest conditions. In our study, streams in the 0-m buffer group showed 1.4–4.4°C increases in mean weekly maximum temperatures and 2.3°C increases in diurnal fluctuation.

Temperature increases in our 11-m treatment group were similar to other studies with wider buffers. The increases in diurnal fluctuation were smaller than observed in other studies with larger buffers. In the 11-m treatment group, postharvest increases in mean weekly maximum temperature ranged from 1.2 to 1.3°C, temperature changes within the harvest zone increased by 1.4–2.5°C, and diurnal fluctuation in temperature increased by 0.5–0.7°C. The 23-m and partial-harvest treatment groups did not exhibit postharvest changes in the temperature. Previous studies showed postharvest temperature increases of 1.0–2.6°C for buffers 15–30 m wide (Rishel et al. 1982, Lynch et al. 1984, Kochenderfer and Edwards 1991, Jackson et al. 2001). These studies also showed streams with 20–30-m wide buffers had 0.7–2.0°C increases in diurnal fluctuation (Rishel et al. 1982, Lynch et al. 1984, British Columbia, Macdonald et al. 2003) over preharvest or control conditions.

The smaller degree of temperature change relative to previous studies we observed in unbuffered streams might be partly attributed to groundwater inflow. Groundwater inputs can strongly influence stream temperature (Sullivan et al. 1990, Caldwell et al. 1991), and inflow can mitigate effects of canopy removal by slowing temperature increases (Poole and Berman 2001) and by aiding in stream temperature recovery (Ice 2001). The glacial till subsurface characteristic of our study region facilitates underground water flow. Also, the close proximity of our study reaches to the watershed divide suggests that a large proportion of groundwater feeds these stream systems. The importance of groundwater to stream temperatures in our study areas was illustrated by temperature measurements taken at 20-m intervals on a hot, sunny day (air temp = 31°C). We observed decreases in stream temperature between 1.2 and 3.2°C within 20 m of stream channel due to several cold groundwater inputs entering the stream channel. We suspect groundwater inflow played a significant role in mitigating the effect of canopy removal in our study. Variations in inflow among stream buffer studies could be a key factor for explaining observed differences in the effectiveness of different buffer widths.

Elevation of water temperature and diurnal fluctuation is a concern because aquatic organisms have adapted to living in systems within a particular temperature range in which body size, fecundity, and survival are optimized (Vannote and Sweeney 1980). Increased water temperature can result in physiological stress and potential death in brook trout (Grande and Anderson 1991). Documented lethal water temperature limits for brook trout range from 24.4°C (Brett 1956) to 26.2–27.2°C (Grande and Anderson 1991). The United States Environmental Protection Agency recommends that mean weekly maximum water temperatures do not exceed 24°C for even one week in streams with populations of brook trout (EPA 1986). In our study, mean weekly maximum temperatures never exceeded 22°C; even in the 0-m treatment group.

Downstream Temperature Recovery

Temperature recovery downstream of a harvest zone is important to understand because a rapid decrease in temperature over a short distance can effectively limit the spatial impact of the harvest. In the 0-m treatment group, temperature changes between the 400-m (upstream of the harvest zone) and 0-m (100 m below the harvest zone) were significantly elevated over preharvest levels in one of the postharvest years. This indicates that without buffers, temperature increases persist for at least 100 m below the harvest zone in the first postharvest year. How far downstream the temperature increases persisted is not known.

Within the 100-m recovery zone we observed relatively large decreases in stream temperature. In the second postharvest year, temperature increases did not persist 100 m below the harvest zone despite being significantly elevated before entering the 100-m recovery zone. Previous studies of temperature recovery downstream of timber harvest showed large decreases in a relatively short downstream distance. Temperature decreases of approximately 1.5°C were observed within 130 m (Caldwell et al. 1991), 2.5°C within 200 m (British Columbia, Story et al. 2003), and 2.0°C within 300 m (Oregon, Zwieniecki and Newton 1999) after streams re-entered intact forest canopy. This common observation of relatively rapid reduction in temperature occurs because the intact forest canopy below the harvest zone shields the stream bed from direct solar radiation (Brown and Krygier 1970), while groundwater inflow and hyporheic exchange further mitigates temperature increases produced in the harvest zone (Sullivan et al. 1990, Caldwell et al. 1991, Johnson and Jones 2000).

Temporal Temperature Recovery

Temperature recovery over time can also be important for forest management decision-making. We only had 2 years of postharvest data, and no temperature recovery was apparent in the 0-m treatment group at the 100-m stations within that time frame. However, shade from a regenerating shrub layer may function as effectively as mature canopy at shading the stream from solar radiation (Johnson and Jones 2000). Low vegetation (shrubs and saplings) and in-stream woody debris and slash can partially shade the stream from solar radiation and mitigate temperature changes associated with harvesting (Feller 1981, Rishel et al. 1982, Caldwell et al. 1991, Jackson et al. 2001). As a result, substantial moderation of stream temperature can occur only 7 years after harvesting, even along streams with no buffers (Ice 2001). We are measuring shrub height each year postharvest for a future study that discusses temperature recovery following timber harvesting.

Conclusions

Forested buffers 11 m wide with ≥60% canopy closure on each side of the stream should protect against significant temperature increases in our study area. The small, statistically nonsignificant increases in temperature associated with 11-m buffers recovered after re-entering intact forest canopy for a distance of approximately one-third the length of the harvest zone. In watersheds with aquatic species that are of special ecological concern, an environmentally conservative management approach may be desirable. Buffers 23 m wide with ≥60% canopy closure on each side of the stream resulted in no detectable temperature changes.

Literature Cited

BEITINGER, T.L., AND L.C. FITZPATRICK. 1979. Physiological and ecological correlates of preferred temperature in fish. Am. Zool. 19:319–329.

BESCHTA, R.L., R.E. BILBY, G.W. BROWN, L.B. HOLTBY, AND D. HOFSTRA. 1987. Stream temperature and aquatic habitat: Fisheries and forestry interactions. *In* Streamside management: Forestry and fishery interactions, Salo, E.O. and T.W. Cundy (eds.). College of Forest Resources, University of Washington, Seattle, WA.

BREN, L.J. 1995. Aspects of the geometry of riparian buffer strips and its significance to forestry operations. Forest Ecol. Manage. 75:1–10.

BRETT, J.R. 1956. Some principles in the thermal requirements of fishes. Q. Rev. Biol. 31:75–81.

BROWN, G.W., AND J.T. KRYGIER. 1967. Changing water temperatures in small mountain streams. J. Soil and Water Conserv. Nov.–Dec.:242–244.

BROWN, G.W., AND J.T. KRYGIER. 1970. Effects of clear-cutting on stream temperature. Water Resource Res. 6(4):1133–1139.

BURTON, T.M., AND G.E. LIKENS. 1973. The effect of strip-cutting on stream temperature in the Hubbard Brook Experimental Forest, New Hampshire. BioScience 23:433–435.

CAIRNS, J. 1970. Ecological management problems caused by heated wastewater discharged into the aquatic environment. Water Resource Bull. 6:868–878.

CALDWELL, J.E., K. DOUGHTY, AND K. SULLIVAN. 1991. Evaluation of downstream temperature effects of type 4/5 waters. Timber/Fish/Wildlife Rep. No. TFW -WQ5-91-004. Washington Department of Natural Resources, Olympia, WA. 71 p.

CORBETT, E.S., J.A. LYNCH, AND W.E. SOPPER. 1978. Timber harvesting practices and water quality in the eastern United States. J. For. 76:484–488.

ENVIRONMENTAL PROTECTION AGENCY. 1986. Water quality criteria. EPA 440/5-86-001. Office of Water Regulations and Standards, Washington, DC 477 p.

DUNN, O.J. 1961. Multiple comparisons among means. J. Am. Statist. Assoc. 56:52–64.

DUNNETT, C.W. 1955. A multiple comparison procedure for comparing several treatments with a control. J. Am. Statist. Assoc. 50:1096–1121.

FELLER, M.C. 1981. Effects of clearcutting and slashburning on stream temperature in southwestern British Columbia. Water Resource Bull. 17(5):863–867.

GRANDE, M., AND S. ANDERSON. 1991. Critical thermal maxima for young salmonids. J. Freshwater Ecol. 6(3):275–279.

HEWLETT, J.D., AND J.C. FORTSON. 1982. Stream temperature under an inadequate buffer strip in the southeastern piedmont. Water Resource Bull. 18(6):983–988.

HOWELL, D.C. 1982. Statistical methods of psychology. PWS Publishers, Boston.

ICE, G. 2001. How direct solar radiation and shade influences temperature in forest streams and relaxation of changes in stream temperature. Cooperative monitoring, evaluation and research (CMER) Workshop: Heat transfer processes in forested watersheds and their effects on surface water temperature, Oct. 2001. Washington Department of Fish and Wildlife, Lacey, WA.

JACKSON, C.R., C.A. STRUM, AND J.M. WARD. 2001. Timber harvest impacts on small headwater stream channels in the coast ranges of Washington. J. Am. Water Resource Assoc. 37(6):1533–1549.

JOHNSON, S.L., AND J.A. JONES. 2000. Stream temperature responses to forest harvest and debris flows in western Cascades, Oregon. Can. J. Aquat. Sci. 57(Suppl. 2):30–39.

KOCHENDERFER, J.N., AND P.J. EDWARDS. 1991. Effectiveness of three streamside management practices in the central Appalachians. *In* Proceedings of the 6th biennial southern silviculture research conference, Vol. 2. Memphis, TN, Oct. 30–Nov. 1, 1990, Coleman, S.S. and D.G. Neary (comps., eds.). Gen. Tech. Rep. SE-70, U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station, Ashville, NC. 1:688–700.

LEMMON, P.E. 1957. A new instrument for measuring forest overstory density. J. For. 55(9):667–669.

LEOPOLD, L.B., M.G. WOLMAN, AND J.P. MILLER. 1964. Fluvial processes in geomorphology. Wlt. Freeman, San Francisco, CA. 134–150.

LYNCH, J.A., E.S. CORBETT, AND K. MUSSALLEM. 1985. Best management practices for controlling non-point source pollution on forested watersheds. J. Soil Water Conserv. Jan.–Feb.:64–67.

LYNCH, J.A., G.B. RISHEL, AND E.S. CORBETT. 1984. Thermal alteration of streams draining clearcut watersheds: Quantification and biological implications. Hydrobiologia 111:161–169.

MACDONALD, J.S., E.A. MACISAAC, AND H.E. HERUNTER. 2003. The effect of variable-retention riparian buffer zones on water temperatures in small headwater streams in sub-boreal forest ecosystems of British Columbia. Can. J. For. Res. 33:1371–1382.

MAINE DEPARTMENT OF CONSERVATION. 1999. The state of the forest and forest sustainability standards: Final report to the joint standing committee of the 119th legislature on agriculture, conservation, and forestry. Maine Department of Conservation, Augusta, ME. 39 p.

MURRAY, G.L.D., R.L. EDMONDS, AND J.L. MARRA. 2000. Influence of partial harvesting on stream temperatures in forests on the western Olympic Peninsula, Washington. Northwest Sci. 74(2):151–164.

OLIVER, G.G., AND L.E. FIDLER. 2001. Towards a water quality guideline for temperature in the province of British Columbia. Ministry of Environment, Lands, and Parks, Water Management Branch, Victoria, BC.

POOLE, G.C., AND C.H. BERMAN. 2001. An ecological perspective on in-stream temperature: Natural heat dynamics and mechanisms of human-caused thermal degradation. Environ. Manage. 27(6):787–802.

RICHARDSON, J.S. 2000. Life beyond salmon streams: Communities of headwaters and their role in drainage networks. P. 473–476 *in* Proc. biology and management of species and habitats at risk, L.M. Darling (ed.). Kamloops, BC.

RISHEL, G.B., J.A. LYNCH, AND E.S. CORBETT. 1982. Seasonal stream temperature changes following forest harvesting. J. Environ. Qual. 11(1):112–116.

SAS INSTITUTE INC. 1999. SAS/STAT user's guide, version 8. SAS Institute Inc., Cary, NC. 3848 p.

SEYMOUR, R.S., AND M.L. HUNTER JR. 1992. New forestry in eastern spruce-fir forests: Principles and applications to Maine. Maine Agricultural and Forest Experiment Station, University of Maine, Orono, Maine.

SIDLE, R.C., Y. TSUBOYAMA, S. NOGUCHI, I. HOSODA, M. FUJIEDA, AND T. SHIMIZU. 2000. Stormflow generation in steep forested headwaters: A linked hydrogeomorphic paradigm. Hydrol. Process. 14:369–385.

STORY, A., R.D. MOORE, AND J.S. MACDONALD. 2003. Stream temperature in two shaded reaches below cutblocks and logging roads: Downstream cooling linked to subsurface hydrology. Can. J. For. Res. 33:1383–1396.

SULLIVAN, K., J. TOOLEY, K. DOUGHTY, J.E. CALDWELL, AND P. KNUDSEN. 1990. Evaluation of prediction models and characterization of stream temperatures regimes in Washington.

Timber/Fish/Wildlife Rep No. TFW-WQ3-90-006. Washington Department of Natural Resources, Olympia, WA. 224 p.

VANNOTE, R.L., AND B.W. SWEENEY. 1980. Geographic analysis of thermal equilibria: A conceptual model for evaluating the effect of natural and modified thermal regimes on aquatic insect communities. Am. Nat. 115(5):667–695.

WASHINGTON WATER QUALITY PROGRAM. 2002. Evaluating standards for protecting aquatic life in Washington's surface water quality standards. Rep No. 00-10-070. Washington State Department of Ecology, Olympia, WA. 189 p.

ZAR, J.H. 1996. Biostatistical analysis. Prentice Hall, Upper Saddle River, NJ.

ZWIENIECKI, M.A., AND M. NEWTON. 1999. Influence of streamside cover and stream features on temperature trends in forested streams of western Oregon. West. J. Appl. For. 14(2):106–113.

MAINE DEPARTMENT OF INLAND FISHERIES AND WILDLIFE

Forest Management Recommendations for Brook Trout

Background

Brook trout (*Salvelinus fontinalis*), commonly referred to as squaretail, brookie, and speckled trout, are native to Maine and are the most preferred sport fish sought by Maine anglers. Size may vary, depending on water temperature, productivity, and food sources, but 3 year-old brook trout in Maine lakes may range from 7.5 to 17.5 inches long. Stream populations are typically slower growing, and lengths of 6 to 10 inches are more common place, although some populations mature and reproduce at lengths smaller than 6 inches.

Maine is the last stronghold for wild brook trout in the eastern United States. There are more than twice as many watersheds supporting wild populations in Maine than all of the other 16 states within the historical eastern brook trout range combined. Maine is also the only remaining state with extensive intact lake and pond dwelling populations of wild brook trout.

Brook trout require clean, cool, well oxygenated water and are very sensitive to changes in habitat and water quality. Rivers and streams typically provide spawning and nursery habitat. Adults are commonly resident in streams, but migrate throughout and between drainages to meet seasonal life history requirements.

Stream habitat suitability is maintained by the presence of intact, mature wooded riparian corridors that conserve forest soils, provide shade to reduce stream warming, protect stream water quality, provide cover for fish, and provide a source of woody debris and leaf litter from mature trees that maintain in-stream habitat for fish and the aquatic insects they feed upon. Floodplain and fringe wetlands associated with streams can be a significant source of springs and groundwater discharge that maintain stream flows and cool temperatures during warm low flow summer periods. Protection of these important riparian and wetland functions ensures that the overall health of the stream habitat and watershed is maintained.

Maine brook trout fisheries are unique and highly valuable, but they are vulnerable to habitat alteration that may be caused by poorly planned and implemented land management activities. Well planned forestry operations can protect habitat and help ensure that forests remain as forest; a compatible land use for brook trout and many other fish and wildlife.

Forest Management Recommendations

Brook trout are not afforded any special state or federal regulatory protection for forestry operations, and as such management recommendations are advisory.

The MDIFW recommends following Best Management Practices (BMPs) during all road and trail building activities, as well as timber harvesting. BMPs are detailed in the booklet titled *Best Management Practices for Forestry*, which offers guidance on managing and protecting water quality, installing road-stream crossings, and providing fish passage. This booklet is available at: http://www.maine.gov/doc/mfs/pubs/bmp_manual.htm or contact the Maine Forest Service at 1-800-367-0223.

Potential harmful impacts to fish and wildlife may be further minimized by designating low impact "riparian management zones" adjacent to streams and stream-associated fringe and floodplain wetlands in forest management and harvest plans. Smaller streams may be greatly influenced by land management practices; these systems benefit the most from well-managed and intact riparian corridors.

The MDIFW also recommends limiting the harvest of trees and alteration of other vegetation within 100 feet of streams and their associated fringe and floodplain wetlands to maintain an intact and stable mature stand of trees, characterized by heavy crown closure (at least 60 – 70%) and resistance to wind-throw. In some situations wider buffers should be considered where severe site conditions (e.g., steep slope, vulnerable soils, poor drainage, etc) increase risk to soil and stand stability. Any harvest within the riparian management zone should be selective with a goal of maintaining relatively uniform crown closure.

US Army Corps of Engineers®
New England District

BGS/NEWSME Exhibit #62

NEW ENGLAND DISTRICT COMPENSATORY MITIGATION GUIDANCE

INDEX

Consider the effect of the mitigation site on roads, rights-of-way, site access, and utilities, as well as on drainage, including the potential for flooding both upstream and downstream of the site. Also consider the potential effect of adjoining land uses, including agriculture, residential, and industrial uses, roads, rights-of-way, utilities, and drainage easements on the mitigation site and its success and functions. Urbanization of the watershed may increase runoff and nutrient inputs from stormwater and septic systems. Both sources can degrade water clarity and quality, impacting submerged aquatic vegetation habitats. Identify the location and approximate extent of any existing, adjacent special aquatic sites. Consider whether there are riparian areas along waterways where water quality may be enhanced, or whether there are adjacent woodlands that may buffer aquatic resources from less compatible land uses.

Stormwater Basins - Typically, detention/retention basins are not appropriate for use as compensatory mitigation. Their construction results from requirements of the constructed project to mitigate stormwater concerns for the project itself, not address the lost functions of the impacted wetlands. In addition, they often require frequent maintenance to retain functionality, decreasing their ability to develop a full suite of wetland functions. However, detention/retention basins can serve to minimize the adverse effects of a project on nearby wetlands and waters, provided that the stormwater management system will be maintained for the life of the project.

Other Site Selection Considerations

There are a variety of other considerations which should be taken into account in mitigation site selection. These include watershed-scale features, size and location of sites relative to water sources, compatibility with adjacent land uses and watershed plans, foreseeable effects of mitigation on ecologically important resources, and development trends and anticipated land use changes.

3.f. Difficult to Replace Aquatic Resources

Some types of aquatic resources are "difficult-to-replace." They include, but are not limited to: bogs, fens, springs, streams, and Atlantic white cedar swamps. Impacts to such resources should generally not be compensated for by using in-kind creation as success is too uncertain.

3.g. Amount of Compensatory Mitigation

Like many Corps districts around the country, New England District has developed standard compensatory mitigation ratios to serve as a starting point for developing adequate compensatory mitigation. These ratios provide guidance for all compensatory aquatic resource mitigation required by New England District. They are particularly designed for direct permanent impacts, with additional mitigation required to address temporary fill impacts and secondary impacts (effects on an aquatic ecosystem that are associated with a discharge of dredged or fill materials, but do not result from the actual placement of the dredged or fill material, e.g., fragmenting wildlife habitat, alteration of hydrology, removal of vegetation, degraded water quality, increased turbidity, increased biological stressors, etc.) on another scale. The ratios are based on:

- Complexity of system impacted,
- Likelihood of mitigation success,
- Degree to which functions are replaced, and
- Temporal losses for certain functions (e.g., water quality renovation, wildlife habitat).

These guidelines represent policy guidance for the New England District. As such, they are not intended to represent a binding regulation, and are not intended to be enforceable against the Army Corps of Engineers by third parties. While these ratios are the starting point for developing appropriate compensatory mitigation, there continues to be flexibility on a project-by-project basis in order to achieve the most appropriate mitigation for a specific project and, based on the facts of a particular situation, permit decisions may result in different requirements than the ratios set forth in this document. The functions and levels of functions impacted are important in determining adequate and appropriate compensation. Some of the factors to be considered in developing the project-specific compensation include:

- The functions provided by the proposed impact site (including the level of those functions).
- The functions provided by the proposed compensatory mitigation project (including the estimated level of those functions upon completion of construction and completion of the monitoring period – as opposed to the level of functions at the site's "maturity" which may be decades in the future).
- Temporal losses of aquatic resource functions.
- The method of compensatory mitigation (e.g., restoration, creation).
- The likelihood that the compensatory mitigation project will attain the performance goals.
- Any risks and/or uncertainties associated with the proposed compensatory mitigation project.
- The distance between the impact site and the compensatory mitigation project site, particularly if they are in different HUC-8 watersheds or ecoregions.
- The relationship between the impacted watershed and the watershed served by the mitigation project.

This flexibility may lead to compensatory mitigation deemed adequate and appropriate which is at different ratios than included here. Project-specific ratios may be lower than depicted here, or they may be higher so that unavoidable impacts to high quality wetlands may be adequately mitigated and/or secondary impacts may be addressed. Proven mitigation methods and confidence that the proposed plan substantially reduces the risks inherent in wetland construction may also be considered in determining the appropriate ratios for a specific project. The New England District will also work closely with state regulatory agencies to achieve as much consistency as possible, given differing state and federal legislative and program requirements; however, these guidelines are designed to meet the federal compensation requirements and may not meet state requirements.

Recommended Ratios for Direct Permanent Impacts (Table 1)

It is extremely important to mitigate for affected functions, generally by replacing the same type of system impacted. This will vary with watershed and landscape considerations; the mitigation should be functionally and geographically appropriate. The ratios are based on the type of aquatic resource impacted, not the type of aquatic resource proposed for compensation. They were developed with the presumption of in-kind compensation (which will not always be appropriate) and ranges are meant to reflect the quality of aquatic resource and the level of functions impacted. In cases where out-of-kind compensation is performed, project-specific ratios will be developed.

Several specific types of systems (e.g., vernal pools, riffle and pool complexes) are not specified here as they will generally require resource-specific and project-specific compensation.

The proximity of impaired waters will be considered. Greater mitigation ratios may be needed for projects near impaired waters to protect water quality. Impaired waters are those waters which do not meet state water quality standards (even after point sources of pollution have installed the minimum required levels of pollution control technology). It is the responsibility of the applicant to identify whether a project is in the vicinity of a designated impaired water by referring to a state's or tribe's Clean Water Act Section 303(d) list and/or maps of impaired waters.

In the case of eelgrass habitat, degraded water quality will be a major determining factor in whether a mitigation project achieves success. When an applicant proposes a mitigation project in designated impaired waters, the expected lower success rate will be considered. Hence, locating eelgrass mitigation in impaired waters should be contemplated only after all other alternative sites have been ruled out.

Recommended Mitigation for Temporary and/or Secondary Impacts (Table 2)

Impacts to aquatic resource functions resulting from temporary placement of fill or as a secondary impact of the permanent or temporary placement of fill can be substantial. In most cases, it will be necessary to compensate for such temporary and secondary impacts to prevent a net loss in aquatic resource functions. Corps regulations published in the March 12, 2007 Federal Register state in C.20(h): "Where certain functions and services of waters of the United States are permanently affected, such as the conversion of a forested or scrub-shrub wetland to a herbaceous wetland in a permanently maintained utility line right-of-way, mitigation may be required to reduce the adverse effects of the project...." In temporary fill situations, although the fill remains in place only temporarily, impacts typically remain after the fill is removed. For example, there may be shearing caused by pressure on organic or fine-grained soils which presses the soil outward, causing upheaval. There may also be compaction which can result in changes to movement of subsurface and/or surface water and conversion of wetland type within and/or adjacent to the temporary fill area. There may be conversion to upland in upheaval areas. If an applicant feels they can avoid these impacts, they can elect to refute the presumption of impacts requiring compensation by performing monitoring. This would involve collecting data on pre-construction conditions (elevations to 0.5', vegetative community composition and type, hydrologic regime such as saturated to surface or inundated) within the footprint and 25' on each side and then repeating that annually during the growing season for five years after the temporary fill is removed. If, after five years (or less), the data show long-term or permanent impacts, compensation will be required. Funds should be held in escrow for this possibility. NOTE: The monitoring may only obviate the need for compensation for the impacts of the temporary fill; any temporary conversion of forest will still require compensation.

Recommendations for mitigation for temporary (in addition to restoration in place) and secondary impacts are expressed as ranges of percentages of the mitigation recommended for direct, permanent impacts. There are several factors to consider when applying the ranges to determine the appropriate level of mitigation for a specific project. Factors to consider for:

- Removal of forested wetland vegetation include density and diversity of original woody vegetation, soil type (organic or mineral), effects of substrate compression, work during frozen conditions only, original aerial cover, presence/absence of exemplary vegetative community, threatened and endangered species habitat, length of time fill will be in place, likelihood of shearing causing upheaval, etc. Habitat is presumed to be the principal function affected but there may also be changes in soil temperature, a window of opportunity for invasion by exotic species, temporary reduction in biomass and carbon sequestration, and changes to hydrology as a result of reductions in evapotranspiration. Compensatory mitigation addresses temporal impacts during the time temporary fill is in place and during forest re-establishment.
- Temporary and secondary impacts to scrub-shrub and emergent wetlands, factors to consider include soil type, effects of substrate compression, work during frozen conditions only, presence/absence of exemplary vegetative community, threatened and endangered species habitat, length of time fill will be in place, likelihood of shearing causing upheaval, etc.
- Vernal pool buffer impacts, factors to consider include original aerial cover, relationship to other vernal pools, etc.

TABLE 1 - RECOMMENDED COMPENSATORY MITIGATION RATIOS FOR DIRECT PERMANENT IMPACTS

Mitigation / Impacts	**Restoration**[1] **(re-establishment)**	**Creation (establishment)**	**Enhancement (rehabilitation)**	**Preservation (protection/ management)**
Emergent Wetlands (ac)	2:1	2:1 to 3:1	3:1 to 10:1[2]	15:1
Scrub-shrub Wetlands (ac)	2:1	2:1 to 3:1	3:1 to 10:1[2]	15:1
Forested Wetlands (ac)	2:1 to 3:1	3:1 to 4:1	5:1 to 10:1[2]	15:1
Open Water (ac)	1:1	1:1	project specific[3]	project specific
Submerged Aquatic Vegetation (ac)	5:1	project specific[4]	project specific[5]	N/A
Streams[6] **(lf)**	2:1[7]	N/A	3:1 to 5:1[8]	10:1 to 15:1[9]
Mudflat (ac)	2:1 to 3:1	2:1 to 3:1	project specific	project specific
Upland[10] **(ac)**	$\geq$10:1[11]	N/A	project specific	15:1[12]

[1] Assumes no irreversible change has occurred to the hydrology. If there has been such a change, then the corresponding creation ratio should be used.
[2] Based on types of functions enhanced and/or degree of functional enhancement.
[3] Might include planting submerged and/or floating aquatics and/or removal of invasive species.
[4] Rare cases, e.g., removal of uplands, old fill, etc.
[5] E.g., remove pollutant source such as an outfall, remove moorings.
[6] Note that this assumes both banks will be restored/enhanced/protected. If only one bank will be restored/ enhanced/protected, use half the linear foot credit.
[7] E.g., daylighting stream, elimination of concrete channel.
[8] Enhancement of denuded banks and channelized streams = 3:1.
Enhancement of denuded banks when there is a natural channel = 4:1.
Enhancement when there are vegetated banks but the stream has been channelized = 5:1.
[9] Preserving buffer within the 100-foot minimum from channel = 10:1.
Preserving additional buffer 100 to 250 feet from channel = 15:1.
[10] This is when upland is used for wetland mitigation, NOT mitigation for upland impacts, which are not regulated.
[11] Only applies if existing condition is pavement or structure AND should complement aquatic functions.
[12] 100' upland buffer recommended for restoration, creation, and enhancement sites would be credited here.

TABLE 2 - RECOMMENDED COMPENSATORY MITIGATION FOR TEMPORARY AND/OR SECONDARY IMPACTS

IMPACT	% OF STANDARD[13] AMOUNT[14]
Temporary fill (swamp mats, fill over membrane) in forested wetlands; area to revegetate to forest.	10-25%
Temporary fill in emergent or scrub-shrub; area to revert to previous condition.	5-20%
Temporary fill in forest and will be permanently converted to scrub-shrub or emergent	15-45%[15]
Permanent conversion of forested wetlands to other cover types	15-40%
Removal of forested wetland cover for new corridor	Project specific
Removal of forested cover of vernal pool buffer (w/in 250' of pool) when percentage of disturbance exceeds 25% of the total VP buffer area	Project specific[16]
Streams – clearing of upland forest and/or scrub-shrub vegetation within 100' of stream bank or outermost channel of braided stream	Project specific[17]
Wetlands within subdivisions	Project specific

[13] "Standard" refers to amount of compensation that would be recommended under either the Corps' mitigation ratios for permanent fill (TABLE 1) or that required in In-lieu fee payments using the standard calculation.
[14] Percentages <u>may</u> be reduced if appropriate project-specific BMPs are incorporated into the project.
[15] For widening existing corridors only, not new. This does not take into account fragmentation impacts.
[16] Considerations in determining appropriate mitigation for secondary impacts to vernal pools should be on overall impact to the upland vernal pool buffer and how this affects the functions of the pool.
[17] Considerations in determining appropriate mitigation for secondary impacts to streams from loss of upland buffer should be on overall impact to the upland stream buffer and how this affects the functions of the stream.

- Stream buffer impacts include distance of impact from stream, width of impact, original aerial cover, etc. Secondary impacts may include water temperature, water quality, fish and wildlife habitat (including travel corridors), production export, and streambank stabilization.

A sample hypothetical calculation of appropriate mitigation using the ratio guidance is posted on the New England District website: http://www.nae.usace.army.mil/reg/index.htm under "Mitigation."

3.h. Preservation Documentation

There are numerous forms of preservation documents. They include fee transfer to another entity such as a non-profit conservation organization or public agency with a conservation mandate, easement given to a non-profit conservation organization or public agency with a conservation mandate, deed restriction, or restrictive covenant. The form should be specified in the text and a copy of the draft document(s) included. Fee transfer with third party enforced conservation covenants or conservation easements is preferred. Deed restrictions are discouraged as they are difficult to enforce and may be easily changed.

3.i. Buffers

In most cases, a protected (preserved) buffer will be required around creation, restoration, and enhancement sites, including stream mitigation, as this is of benefit on a local and watershed scale throughout New England. The extent of the buffer will depend upon the landscape position of the site(s) and current and potential surrounding land uses but it will be rare that a buffer less than 100 feet in width will be adequate. Buffers greater than 100 feet in width are generally encouraged. Usually buffers will consist of uplands but wetlands also may serve that function in some situations. Vernal pools require a substantial area of adjacent forested terrestrial habitat (both upland and wetland) in order to adequately support vernal pool dependent wildlife. The buffer requirements for projects involving vernal pools may be greater than 100 feet in width.

Compensatory mitigation that involves restoration, creation, and enhancement benefits greatly from the presence of upland buffer to prevent site degradation resulting from nearby activities and enhances long-term sustainability. This buffer area would count toward upland preservation mitigation credit. A preserved buffer of a minimum of 100' from each bank is recommended for stream restoration and enhancement projects, but may be smaller based on landscape features. Eelgrass also benefits from the protection of headwater streams, nearby lands, and adjacent bottom habitat but the potential for compensation credit will be dependent upon site and project-specific circumstances.

Labbe, Jeremy M.

Pre-filed Rebuttal Testimony of Jeremy Labbe
Before the Board of Environmental Protection

Juniper Ridge Landfill Expansion

DEP APPLICATIONS #S-020700-WD-BI-N & #L-024251-TG-C-N

This rebuttal testimony addresses several statements contained in Edward Spencer's July 29, 2016, direct testimony on the Juniper Ridge Landfill (JRL) Expansion application filed by the Bureau of General Services (BGS) and NEWSME Landfill Operations, LLC (NEWSME). The statements I will address are associated with the Maine solid waste hierarchy, the conditions of the Public Benefit Determination, and current and proposed site operations. In addressing these statements I have identified where in the application or direct testimony the information in question is presented, or provided additional supplemental information, to demonstrate that the assertions are incorrect.

I. MAINE SOLID WASTE HIERARCHY IN REGARDS TO CONSTRUCTION AND DEMOLITION DEBRIS AND OVERSIZED BULKY WASTES

On page 3 of Mr. Spencer's direct testimony he discusses historical waste volumes received at JRL, specifically construction and demolition debris (CDD) related waste volumes. Mr. Spencer's use of various tonnage information from JRL is confusing and potentially misleading, so I will attempt to clarify it below. Mr. Spencer states that "for the last 5 years (2011 through 2015) wastes categorized as CDD, oversized bulky waste (OBW), and CDD processing fines have when combined accounted for over 57% of JRL inputs." Mr. Spencer then uses that number to try to establish two things: first, that OBW is a large category of waste disposal at JRL; and second, that our waste characterization process may be questionable since total disposal tonnages for these materials remain similar year over year.

First, I can personally attest to our waste practices as the one who oversees the waste characterization program at JRL. We perform our duties with the purpose of being complete and accurate in our characterization, and our team works with skill and integrity. The waste JRL accepts is properly characterized and is in-state waste under 38 M.R.S. § 1310-N(11).

Second, CDD materials have been the largest category of material since 2005 and in the expansion application we projected this to continue. According to the Maine Solid Waste Generation and Disposal Capacity Report: Calendar Year 2014, a total of 1,114,326 tons of material were disposed in landfills across the State, excluding generator owned landfills, see BGS/NEWSME Exhibit 63. Of that State total, JRL accepted 629,021 tons, or about 56%. During the same year, JRL accepted 373,820 tons of CDD related materials, which includes CDD, OBW, and CDD processing fines, or about 59% of the total material accepted. Despite being considered in the disposal totals, CDD processing fines are actually utilized as an alternative daily cover significantly reducing the need for virgin soil materials. The Maine Department of Environmental Protection (MEDEP) required use of cover materials is set forth in 06-096 CMR 401(4)(C)(8). In short, JRL accepts just over half the total waste disposed in Maine, and just over half of the material accepted at JRL is CDD related. Additionally, JRL utilizes one of these materials, CDD processing fines, as an alternative cover material significantly reducing need for valuable virgin soil materials.

Third, CDD and CDD processing residuals are the second largest waste category needing landfilling, even after the 60.13% "diversion from disposal" rate achieved by Maine in 2014. In her direct testimony, Ms. King testified extensively about CDD, discussing what Casella is doing to reduce, reuse, and recycle this material. Consequently, since two of the three CDD materials (OBW and CDD processing fines) Mr. Spencer discusses are actually residues and come from licensed processing facilities in Maine, which to my knowledge are in full compliance with their licenses and meet the recycling standard for processing facilities, it appears that Mr. Spencer is trying to utilize an argument about the waste hierarchy to pursue his views on the definition of in-state waste, which is not a relevant license criterion.

During the same discussion, Mr. Spencer focuses on the OBW acceptance rate, but he only points at the rate through 2011, despite the fact that just before this he discusses total CDD materials accepted at JRL from the years of 2011 to 2015. To look solely at OBW increasing through 2011 is misleading. If we look at the disposal rates at JRL from 2011 through 2015, OBW materials have decreased from a peak of 98,880 tons in 2011 to 47,388 tons in 2015. These tonnages come from in-state sources whose operations are governed by their individual licenses and MEDEP oversight. The purpose of the JRL is to provide disposal capacity vital to these generators' Maine operations and to safely dispose of their waste residuals from processing, not control their waste generation.

Mr. Spencer correctly notes that Pine Tree Landfill (PTL) in Hampden, which was a source of disposal for many CDD materials, ceased accepting waste at the end of 2009. The result was that the Maine waste PTL was accepting moved to a new disposal location at JRL, which additionally provides an answer to his question about why CDD material acceptance rates were increasing at that time.

I will now respond to Mr. Spencer's questions from page 3 of his testimony.

1. *"Who determines which category a truckload of waste is put into, and where does this determination take place?"*

   First, as noted above, JRL accepts only Maine wastes, and each waste load is detailed in the monthly reports we provide to the MEDEP, the BGS, the City of Old Town, and the Landfill Advisory Committee (LAC). Second, the definitions of Construction and Demolition Debris, as well as Residue from processing facilities, are set forth in 06-096 CMR 400(1)(FF) and (1)(Tt) of the Maine Department of Environmental Protection Solid Waste Management Rules, respectively, see BGS/NEWSME Exhibit 64. The generator is responsible for properly identifying the material and providing a proper manifest at the JRL scales stating what the material is. Also, JRL staff is diligent in checking loads for unacceptable materials, as detailed in our Operations Manual, specifically in our Waste Characterization and Acceptance Plan and our Waste Inspection Plan, and in making sure loads are properly identified by the generator. Haulers are additionally required to sign each weight ticket stating that the materials are properly classified, described, packaged, and identified as seen in an example waste ticket provided in BGS/NEWSME Exhibit 65. This occurs with each and every load of material coming into JRL. Additionally, as discussed previously, JRL provides a load by load breakdown of waste accepted monthly to the City of Old Town, the LAC, and the MEDEP, and maintains paper copies of weight tickets for each load of material accepted at the facility. This system is very robust, and provides a very high level of transparency.

2. *"Why then did combined categories of CDD wastes into JRL increase so drastically after PTLF closed? If the wastes going into PTLF pre-closure were primarily Maine wastes, why weren't they already going to JRL? And if the increased volumes of CDD categories of wastes into JRL post-PTLF are truly Maine wastes only, what explains the increases at that time?"*

What Mr. Spencer refers to as a "drastic" increase in JRL waste accepted during this time period, is approximately an 18% increase. Considering the closing Pine Tree Landfill (PTL), one of the largest landfills in the State, in 2009, that is not a major increase. Second, Maine wastes may be disposed lawfully at any appropriately licensed disposal facility. Just because JRL is a Maine-waste only facility does not mean that when PTL was operating all Maine wastes went to JRL instead of PTL. When it was operating, PTL accepted many types of waste from many sources in Maine. Many of these needed a new disposal location once PTL closed, resulting in the increase in waste acceptance at JRL following the PTL closure. Mr. Spencer implies that some of the material disposed at JRL is not "truly" Maine waste. As stated previously, all material disposed at JRL is waste generated in Maine by statutory definition. Additionally, a review of the combined annual tonnages from MEDEP annual reports when PTL and JRL were both operating, and annual tonnages at JRL after PTL's closure shows that the increase at JRL is small in comparison to what PTL and JRL accepted combined while both were operating. In 2008 and 2009, for example, the last two years of operation at PTL, PTL and JRL combined annual tonnage accepted was 1,057,097 and 957,801 tons, respectively. In comparison, the waste acceptance in 2010 and 2011 at JRL, post-PTL closure, was 708,198 and 703,880 tons respectively, a decrease of over 300,000 tons per year, on average.

3. *Why do OBW tonnages into JRL vary so widely over the lifetime of JRL? Since KTI (Casella's former CDD processing facility in Lewiston) was sold (2013) does the majority of the OBW still come through that facility?*

OBW tonnages at JRL do vary from year to year based on generation rates of the facilities in Maine that deliver OBW to JRL. These changes can be due to operational changes at those facilities, or variability in the waste streams they accept, or changes in total waste acceptance. As discussed above, it is JRL's responsibility to provide disposal capacity vital to these generators' operations and to safely dispose of their waste residuals from processing, not control their waste generation. Additionally, during years when both JRL and PTL were in operation, OBW was disposed at both landfills, reducing the total OBW accepted at JRL. The answer to the second part of this question was provided in an August 1. letter from Don Meagher of NEWSME to the MEDEP in response to an email from Kathy Tarbuck requesting a breakdown of OBW quantities received at JRL by generator name and year. This letter is included in BGS/NEWSME Exhibit 66.

II. ODOR CONTROL/REPORTING

On page 6 of Mr. Spencer's testimony he discusses odor control/reporting. I will reiterate, as I said in my direct testimony, that the odor complaint management plan at JRL is extremely robust and comprehensive. I am not aware of another facility in the state of Maine with a system like ours. Our phone complaint line is staffed 24 hours a day, 7 days a week, including all holidays. Mr. Spencer asserts that "if you are lucky, someone will answer," which is simply incorrect. I believe the basis for his assertion is a single complaint lodged by Mr. Spencer on March 24, 2016, at 7:25 am that was not answered immediately via phone. Mr. Spencer proceeded to visit the site and personally report the odor and was understandably upset about not getting a representative on the complaint line and having to leave a message. The reason the odor line was not answered at that time was investigated and determined to be a call forwarding error that had occurred that morning. This error was promptly corrected. Our staff went above and beyond once Mr. Spencer showed up on site. We gave Mr. Spencer a tour of our landfill gas treatment facility, allowed him to walk around the facility to see if the odor he detected on Kirkland Road at his house, approximately 1.7 miles away, was similar to anything around the facility, and offered a sincere apology for our technical issue with the phone and logged his complaint immediately. Besides this one event, Mr. Spencer has successfully lodged many other complaints. So far in 2016, with six complaints, Mr. Spencer has made about 45% of the total odor complaints received. Every odor complaint is reported monthly to the MEDEP, the BGS, the City of Old Town, and the LAC.

With regard to our questioning procedures during a call, our odor complaint record form and procedures were implemented with the assistance of the MEDEP and is designed to assist our responders in keeping communication uniform across all callers with the same form and question set. You can see the odor complaint log form provided as BGS/NEWSME Exhibit 67. The caller has an opportunity to say whatever he or she wants during the call and is encouraged to describe the odor, which is recorded onto the form. Every odor complaint is logged into this form, maintained as a record, and provided as a summary to the LAC, the City of Old Town, and the MEDEP monthly, contrary to Mr. Spencer's statement that "if it does not fit a category it will not be recorded as a legitimate complaint." This is all part of the very rigorous Odor Complaint Management Plan provided as part of the application and my previous testimony.

Our responders are extremely qualified to respond to complaints in an effort to determine the source of the odor, as well as intensity. Additionally, we utilize one of the most advanced H_2S monitoring instruments available to assist responders in detecting H_2S, one of our primary potential odors, at locations of complaints when a site visit is requested by the caller. Stating that our trained personnel suffer from "olfactory fatigue" is an unfortunate attempt to discredit those who are trained specifically in odor detection and have years of successful experience in the practice. Mr. Spencer also states that "I have also heard of Casella blaming odors on the company that runs the on-site gas filtration system." This is incorrect. This system, known as the Thiopaq® gas treatment system, which removes H_2S from the landfill gas prior to combustion, is a system we operate and have always operated from day one. There is no, nor has there ever been, a third party operation of any such facility at JRL.

In reference to Mr. Spencer's comments about getting the Old Town police involved in odor detection, as I previously discussed, the City of Old Town already receives a summary of every odor complaint at JRL, and JRL can provide copies of the individual completed odor complaint forms should they be requested by the City. If an Old Town police officer, any other city employee or citizen detects an odor while around our facility, he or she may call our odor complaint line and report the odor. This is its purpose. Additionally, JRL maintains an open relationship with both the Old Town Police and Fire Departments, which includes regular site visits to familiarize the officers and firefighters with our site, and both are encouraged to visit whenever they would like.

Mr. Spencer suggests that we should use a device called the Nasal Ranger, a device with which we are very familiar. I personally have had the opportunity to use this device, and I, along with other current JRL staff, completed an extensive test using this device in 2009. Ultimately we opted to not utilize the Nasal Ranger as it was useful in quantifying a level of odor, but not in identifying the type of odor. Should we have an issue regarding the level of odor, a Nasal Ranger is very useful and would be considered along with other available techniques. As we strive for no offsite odor from JRL, any odor we detect or complaint we receive pertaining to our facility and operations is something we strive to correct, regardless of the level of odor. Our goal is to eliminate odor, not just keep odor below a certain threshold. Additionally, our staff actually took part in an Odor School put on by St. Croix Sensory, the maker of Nasal Ranger, at JRL in 2009, and were certified in odor detection practices. The teacher of this school was the inventor of the Nasal Ranger, Charles McGinley. Please see attached certificate of training completion in BGS/NEWSME Exhibit 68 from one of our JRL staff. This is one of multiple trainings our staff has taken part in and provides more insight about the level to which our responders are trained in odor detection and identification.

Lastly, in reference to Mr. Spencer's comment that there are "other fugitive landfill gases besides hydrogen sulfide," I agree. Methane in sufficient concentration is also a safety concern as it is with natural gas, and we do monitor methane in structures around the site as detailed in our Operations Manual. There is a specific rationale, however, for monitoring specifically H_2S both on-site and off-site. H_2S is heavier than air and it is also very odorous, even at very low concentrations. Methane, on the other hand, is lighter than air, and odorless. Therefore H_2S can remain low, following ground contours, and methane will rise away from the ground, making H_2S the ideal ground level monitoring parameter for both odor and gas migration. Methane is monitored on-site for operations and safety in gas collectors, at the surface of the cover system, and in pump stations and other structures around site. Additionally on-site personnel working with gas infrastructure wear meters that detect both H_2S and methane (though measurement of the lower explosive limit) for personal safety. In both H_2S and methane monitoring applications, we utilize many different types of advanced monitoring devices, many of which are connected to our real time supervisory control and data acquisition (SCADA) system where alarms may go out to personnel 24 hours a day. One of the best examples, as discussed in my direct testimony, is our remote real-time monitoring of H_2S at multiple locations off-site. As part of this application, as discussed by the City of Old Town in its direct testimony, we have agreed to implement action levels of notification to the City in the unlikely event of an off-site H_2S spike at any of these locations of 15 parts per billion (ppb) or 30 ppb, and this will be included as part of the notification protocol in the Operations Manual. Additionally, we will be providing the raw data annually to the City upon request for its separate third party review of the data to assure there are no chronic H_2S exposure concerns. This separate review will provide a third level of review on top of the already completed internal JRL staff review as part of the Annual Report, and independent MEDEP review, as the raw data is also currently provided to the MEDEP.

Dated: 9/8/16 [signature]
Jeremy M. Labbe

STATE OF MAINE
Cumberland, ss.

Personally appeared before me the above-named Jeremy Labbe and made oath that the foregoing is true and accurate to the best of his knowledge and belief.

Before me,

Dated: 9/8/16 [signature]
Notary Public
Name: Elizabeth Fox-Michelini
My Commission Expires: October 2017

ELIZABETH A. FOX-MICHELINI
Notary Public, Maine
My Commission Expires October 1, 2017

BGS/NEWSME Exhibit #63

Report to the Joint Standing Committee on the Environment and Natural Resources

127th Legislature, Second Session

Maine Solid Waste Generation and Disposal Capacity Report: Calendar Year 2014

January 2016

Contact:

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Contents

I. Executive Summary

This report is submitted to the Joint Standing Committee on Environment and Natural Resources pursuant to 38 M.R.S.A. § 2124-A. It provides an overview of Maine's solid waste generation, diversion, and disposal activities for 2014, the most recent full calendar year of data available, and a projection of how those activities will impact available solid waste disposal capacity.

The report includes a projection of the solid waste disposal needs of Maine for the next 3, 5, 10, and 20 years. The report also projects how the fill rate at each solid waste landfill could affect the expected lifespan of that landfill.

The report must also include an analysis of how changes in available disposal capacity have affected, or are likely to affect disposal prices. When the department determines that a decline in available landfill capacity has generated or has the potential to generate supracompetitive prices, the department shall include this and recommendations for legislative or regulatory changes as necessary.

The information in this report can assist policymakers with planning for future solid waste disposal capacity investment. This report evaluates Maine's progress toward our waste reduction and recycling goals and the impact on disposal capacity.

Highlights

- The total amount of solid waste generated in Maine in 2014 was 2,770,991 tons, an increase from the total of the 2,561,555 tons of solid waste tonnage generated in 2013. Within that total, the tonnage of Municipal Solid Waste (MSW) increased only slightly from 2013 to 2014, the generation of Construction or Demolition Debris (CDD) remained virtually stable, but the tonnage of Special Wastes increased by approximately 26%.

- Almost 26% of Maine's municipal solid waste, construction and demolition debris, and land-clearing debris, and 45% of other solid wastes were diverted from disposal in 2014. Using a calculation method that permits Maine's recycling rate to be compared to that of other states, Maine's MSW recycling rate in 2014 was 36.24%. This decrease is primarily due to a slightly larger tonnage of MSW being generated in 2014, as compared with 2013's tonnage, and a lower tonnage of "Other MSW" Materials being recycled" (electronics, white goods and other metals, tires, vehicle batteries, and asphalt shingles), and was influenced by an improving economy and reduced material recovery efforts, led by lower value for recovered metals and other products.

- The tonnage of food scraps and other organic materials diverted from disposal and sent to composting almost doubled from 2013 to 2014.

- The capacity for disposal of MSW generated in Maine remains adequate into the foreseeable future, based on the currently operating disposal facilities and management systems in place. This includes three waste-to-energy (WTE) facilities, seven municipally-owned landfills, two state-owned landfills, and one commercially-owned landfill.

A. Waste Management Hierarchy

Maine statute establishes a hierarchy for management of solid waste, to be used as a guiding principle in decision-making. 38 M.R.S.A. § 2101(1) establishes:

> *It is the policy of the State to plan for and implement an integrated approach to solid waste management for solid waste generated in this State and solid waste imported into this State, which must be based on the following order of priority:*
>
> *A. Reduction of waste generated at the source, including both amount and toxicity of the waste;*
>
> *B. Reuse of waste;*
>
> *C. Recycling of waste;*
>
> *D. Composting of biodegradable waste;*
>
> *E. Waste processing that reduces the volume of waste needing land disposal, including incineration; and*
>
> *F. Land disposal of waste.*

To provide a broader context in which to view Maine's recycling efforts, the recent *Fact Sheet on Challenges Facing Municipal Solid Waste (MSW) Recycling in the Northeast,* prepared by the Northeast Waste Management Officials' Organization (NEWMOA) and the Northeast Recycling Council (NERC), is included as Appendix B. This document was presented to the Northeast Committee on the Environment (NECOE) at their November 2015 meeting. The NECOE is comprised of the state environmental department's commissioners of the Northeast states.

II. Background

Title 38 § 2124-A requires the Maine Department of Environmental Protection (Department) to annually submit a "Solid Waste Generation and Disposal Capacity Report" to the joint standing committee of the Legislature having jurisdiction over natural resources matters and the Governor. This report must set forth information on the generation of solid waste in Maine, the statewide recycling rate for MSW, and the remaining available disposal capacity for solid waste. The report must also include an analysis of how changes in available disposal capacity have affected or are likely to affect disposal prices, an analysis of how the rate of fill at each solid waste landfill has affected the expected lifespan of that solid waste landfill, and an analysis of consolidation of ownership in the disposal, collection, recycling and hauling of solid waste.

This report focuses on municipal solid waste (MSW) as defined by Maine law. MSW is comprised of household baggable waste and construction demolition debris, including such items as furniture, tires, and metal. The report does include certain sludge and ash tonnages which are considered 'special wastes', since the disposal of those wastes at landfills impacts the disposal capacity remaining at the disposal facility, which is one of the metrics tracked in this report. Special wastes are wastes that are generated by other than households or typical businesses and, due to their quantity or chemical or physical properties, require particular handling. They include primarily ashes, sludge, and some processing wastes. Industrial wastes are not included in this report. Industrial wastes are not part of the waste managed by municipalities.

CDD is solid waste resulting from construction, remodeling, repair, and demolition of structures, including building materials, discarded furniture, wall board, pipes, metal conduits, and similar debris. Most CDD is generated by the household and commercial (building industries) sector, and is considered to be a subset of MSW. To help with planning for solid waste management, solid waste facilities accepting CDD track those materials separately from MSW, to the extent practicable.

The industrial sector also generates significant amounts of other types of solid wastes that are regulated as "special waste" under Maine law because they have chemical or physical properties that make them difficult to handle, or potentially pose a threat to public health, safety or the environment.

This report includes various tables that contain data on solid waste generated in Maine, as well as data on the amounts and types of solid waste managed by disposal facilities in Maine, including sources and tonnages of solid wastes imported to Maine for disposal. The data on solid waste generated in Maine is used to calculate Maine's recycling rate, while the data on wastes accepted for disposal at waste-to-energy facilities and landfills is used to project available disposal capacity into the future.

III. Management of Maine-generated Solid Waste in 2014

The most current, complete data available for solid waste management in calendar year 2014 come from a variety of sources, including:

- licensed public and private processing, composting, and disposal facilities' annual reports submitted to the Department (in accordance with 38 M.R.S.A. §§ 1304-C, 2205, and 2232), and to other states' regulatory agencies (from out-of-state facilities which receive waste from Maine);
- data on the recycling of electronics, tires, vehicle batteries, consumer batteries, mercury-added lamps and textiles was obtained through a combination of voluntary and mandatory reports from the specialized businesses that manage these consumer products. Along with voluntary reporting by major collectors of these items, this included data reported under Maine's product stewardship laws as well as data from hazardous waste manifests; and
- voluntary reporting[1] by commercial entities managing recyclables generated in Maine.

Table 1 presents a summary of the types and amounts of solid waste generated in Maine in 2014.

Table 1 - 2014 Maine Generated Solid Waste by Type and Amount

Waste type	2014 Amount Generated (tons)
Municipal Solid Waste (MSW)	1,187,265
Construction / Demolition Debris (CDD)/wood waste/land-clearing debris	695,876
Special solid wastes (see Table 3 for break out by waste types and amounts)	887,850
Total Maine Generated Solid Waste - 2014	**2,770,991**

These same categories reported 2,561,555 tons of waste being generated in 2013 (MSW 1,161,578; CDD 696,213; Special wastes 704,681). The amount of MSW generated increased slightly (by 25,687 tons) from 2013 to 2014, the generation of CDD remained virtually stable, and the amount of special solid wastes increased from 704,681 tons to 887,850 tons, or approximately 26%. The increase in special waste tonnage was the result of reported increases in the generation of certain ashes and sludges, as well as in contaminated soils.

[1] The Department is appreciative of the data voluntarily provided by a number of generators/brokers of recyclables and acknowledges the reluctance of others in providing their data due to that information not being identified as 'confidential business information'.

Maine's solid waste management infrastructure includes municipal, commercial, and private industrial waste handling facilities. Once collected, solid waste in Maine is stored, transported, recycled, processed, composted, anaerobically digested, beneficially used in place of virgin materials and as fuel, combusted at one of three waste-to-energy facilities, or landfilled.

IV. Progress toward Maine's Waste Reduction and Recycling Goals

In keeping with the Solid Waste Management Hierarchy (38 M.R.S.A. § 2101), there are a variety of options employed for managing Maine's solid waste. Appendix B is a table that provides an overview of management options currently employed for the various components of Maine's solid waste stream. This table provides a qualitative assessment of the comparative use of the management options. The options are grouped by levels on the Hierarchy, with those listed to the left preferable to those toward the right due to the resulting preservation and use of materials. By examining Maine's waste stream by material type and current management options, we can identify opportunities for "moving up the hierarchy", decreasing disposal and increasing waste reduction, reuse, recycling and beneficial use.

Maine's Municipal Solid Waste Reduction Goal

Maine's statutory goals for waste reduction focus specifically on MSW. 38 M.R.S.A. § 2132(1-A) sets a State goal of reducing the biennial generation of municipal solid waste tonnage by 5% beginning on January 1, 2009, and by an additional 5% every subsequent 2 years. The baseline for calculating this reduction is the 2003 solid waste generation data gathered by the former State Planning Office (2,019,998 tons).

It is not possible to project the amount of waste that would have been generated without waste reduction efforts implemented by entities ranging from individuals (e.g., backyard composting) to corporations (e.g., light-weighting of consumer packaging), so the best alternative for measuring waste reduction is using the amount of MSW disposed. Over the past several years, the amount of MSW generated in Maine and disposed of in landfills and waste-to-energy incinerators has declined.

Maine's Municipal Solid Waste Generation Overview

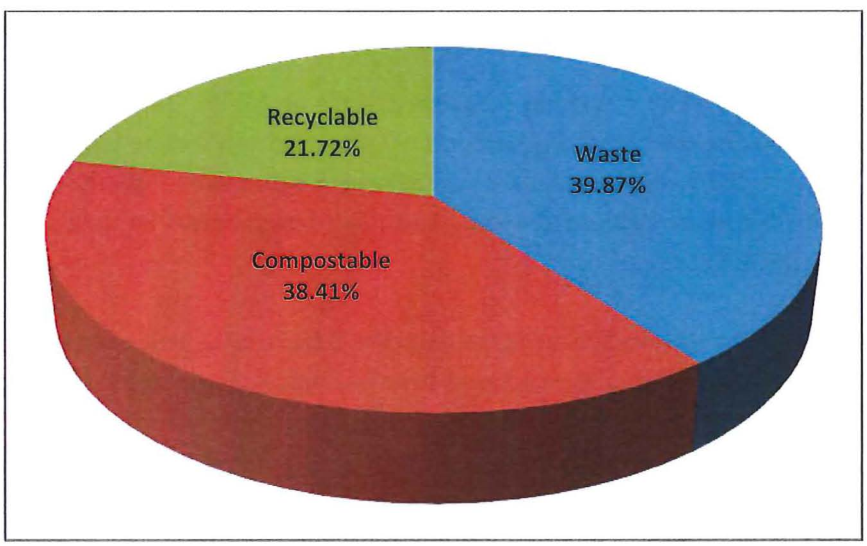
In 2014, Maine residents generated and disposed an average of 0.570 tons (1140 pounds) of MSW per person, an increase from the 0.513 tons per person generated in 2013, which is reflective of an improving economy. In 2008, Maine residents and businesses generated and disposed of 755,086 tons of MSW (exclusive of CDD and Waste-to-Energy ash). The amount of MSW disposed of in 2014 was 757,049 tons, which is slightly above the amount disposed of in 2008.

The most recent regional comparisons of per capita disposal rates available for the Northeast (2012) show Mainers generated an average lower amount of MSW per person that year than most other Northeastern states, which reflected an average of 0.7 tons of MSW generation per person in the Northeastern states, with the rate ranging from 0.52 tons per person for New Hampshire to 0.91 tons per person for Rhode Island.[2]

A. Maine's Municipal Solid Waste Composition and Management

In 2011, the University of Maine was contracted by the former Maine State Planning Office to undertake a study to understand the types of solid waste Maine residents are disposing of in the mixed MSW waste stream. Figures 1 and 2 are reproduced from that report[3] to show the percentages of MSW by material type, reflecting the composition of the waste stream in 2011.

Figure 1 - Composition of Disposed MSW



From: *2011 Maine Residential Waste Characterization Study – School of Economics Staff Paper #601*

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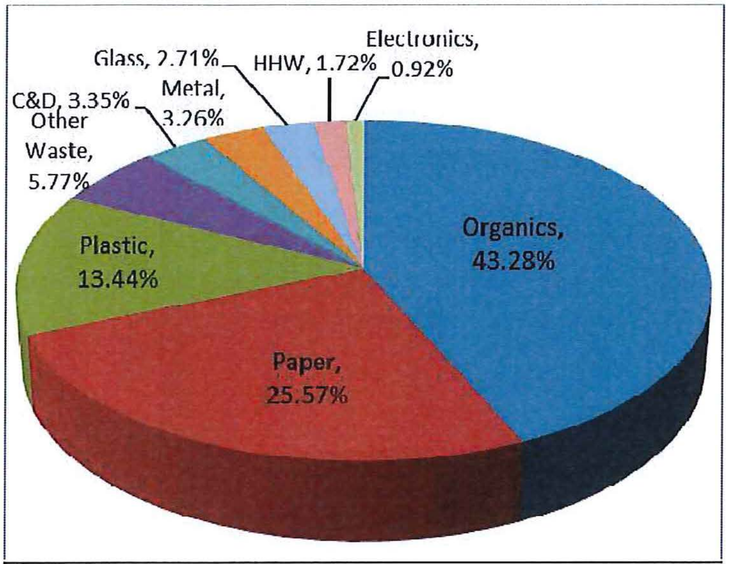
[2] *Municipal Solid Waste (MSW) Interstate Flow in 2012*, March 27, 2015, Northeast Waste Management Officials' Association

[3] *2011 Maine Residential Waste Characterization Study – School of Economics Staff Paper #601*; Criner, George K. and Blackmer, Travis L., University of Maine; http://umaine.edu/wcs/files/2012/02/2011-Maine-Residential-Waste-Characterization-Study1.pdf

Figure 2 - Composition of Disposed MSW by Nine Major Categories



From: *2011 Maine Residential Waste Characterization Study – School of Economics Staff Paper #601*

This 2011 Maine Residential Waste Characterization Study documented organics, paper and plastics as the three largest components in MSW disposed of from Maine. Based upon the results of this study, diversion of organics from disposal remains the largest opportunity to reduce Maine's waste stream, which is why the Department has established an initiative focused on separating and recovering discarded food and other organics.

B. Maine's Municipal Solid Waste Recycling Rate

In 1989, the Maine Legislature enacted 38 M.R.S.A. § 2132, establishing a goal to recycle or compost 50% of the state's municipal solid waste annually. The State remains committed to reaching the 50% goal in light of the value of reducing overall solid waste management costs, the positive impact on the environment, and a lessening of the need for additional solid waste disposal capacity.

The MSW recycling rate is calculated by dividing the total amount of MSW recycled by the total amount of reported in-state generated MSW in accordance with 38 M.R.S.A. § 2132 (3). The term "municipal solid waste" is not defined in Maine law, but has historically been interpreted as solid waste normally managed by municipalities in Maine, including CDD. However, other states and the U.S. Environmental Protection Agency (US EPA) exclude CDD from their calculations of MSW recycling rates. This creates inconsistencies when trying to compare Maine's calculated MSW recycling rate with the MSW recycling rates of other states. To address this, the Department has calculated the recycling rate for MSW as defined by the US EPA, and a separate recycling rate that includes CDD. This approach allows Maine to perform an 'apples-to-apple's comparison with other states' MSW recycling rates, while also enabling Maine to evaluate where further efforts are needed to improve diversion of the broader spectrum of disposed materials handled by municipalities in Maine. All totaled, 45.06% (compared with 2013's rate of 46.72%) of Maine's MSW, CDD and land-clearing debris was diverted from disposal and recycled or beneficially used (see Table 3).

Table 2 (next page) shows the amounts of each waste type managed through disposal, recycling, composting, and beneficial use, and includes calculated recycling and diversion from disposal rates for Maine-generated MSW, CDD, and land-clearing debris.

Table 2 - 2014 Management of Maine's Solid Waste (except Special Solid Wastes)	
Municipal Solid Waste (MSW) Disposition	**Tons**
Maine MSW landfilled in state	249,407
Maine MSW disposed of at waste-to-energy facilities in state (amount destroyed through combustion)	333,344
Maine MSW waste-to-energy ash landfilled in-state	104,775
Maine MSW disposed of out-of-state	69,524
Subtotal Maine MSW (exclusive of CDD) disposed	**757,049**
Recycling/Organics Management	
Paper, cardboard, plastics, metals, glass and textiles recycled	229,609
Other MSW recycled (electronics, white goods and other metals not reported by brokers, tires, and vehicle batteries)	176,979
Reported MSW composted (includes leaf & yard rakings, food scraps)	23,627
Subtotal Maine MSW recycled or composted	**430,215**
Total Maine MSW (exclusive of CDD)	**1,187,265**
Maine's MSW recycling rate (exclusive of CDD)	36.24%
Construction or Demolition Debris	
Mixed CDD landfilled in-state	259,541
Mixed CDD disposed of out-of-state	9,239
Land-clearing debris landfilled	8,688
Composting and beneficial use of processed CDD and land-clearing debris as fuel	60,579
Other beneficial use of processed CDD and land-clearing debris	357,636
Total CDD and land-clearing debris	**695,876**
Maine's CDD & land-clearing debris recycling rate	**8.73%**
Maine's CDD & land-clearing debris 'diversion from disposal' rate	**60.13%**
Summary of Management and Disposition	
Total tonnage of MSW, CDD & land-clearing debris	1,883,141
Total MSW, CDD and land-clearing debris recycled (including wood used as fuel)	490,988
Total MSW, CDD and land-clearing debris diverted from disposal	848,624
Maine's combined MSW, CDD & land-clearing debris 'recycling rate'	**26.07%**
Maine's combined MSW, CDD & land-clearing debris 'diversion from disposal' rate	**45.06%**

Changes in generation of solid waste in Maine from 2013 to 2014 show a positive trend in the management of organics - there has been almost a doubling of the amount of food scraps and leaf and yard rakings composted, from 12,674 tons to 23,627 tons. The 2014 data also show an increase in the amount of Maine MSW being generated and disposed of through landfilling and incineration, which is most likely a reflection of an improving economy. However, the 2014 data show almost 54,000 tons less of metals being recycled than in 2013, perhaps reflecting the peak of metal prices in 2013 when stockpiled metals were sent for recycling. These factors, when combined, result in the statewide MSW recycling rate dropping from 41.36% in 2013 to 36.24% in 2014.

C. Special Solid Wastes and Beneficial Use

Table 3 shows the amounts of solid wastes other than MSW, CDD and land-clearing debris generated in Maine and how each waste type was managed. Almost 16% of these special wastes were composted or used as soil amendments for agronomic benefit. Another 23% was used as fuel in multi-fuel boilers, or beneficially used in another way. The beneficial use of waste is the use or reuse of a solid waste as a raw material substitute in manufacturing, as construction material or construction fill, as fuel, or in agronomic utilization. Unlike the recycling of commodity materials, materials that are beneficially used are not used in products that may continue to be available for recycling. Beneficial use diverts waste from disposal, thus preserving disposal capacity, but it does not preserve materials for on-going recycling.

Table 3 - 2014 Disposition of Maine 'Special Solid Wastes' (in tons)								
WASTE TYPE	**Compost & N-Viro***	**Beneficial Use – Fuel**	**Beneficial Use - other**	**Land applied**	**Anaerobic digestion**	**Combusted**	**Landfilled**	**Totals**
Asbestos/Asbestos Containing Waste	-	-	-	-	-	-	2,718	2,717.90
Ash - Coal, oil and multi-fuel boiler	8,854	-	20,057	26,645	-	-	152,655	208,212
Ash - MSW Incinerator	-	-	-	-	-	-	108,207	108,207
Ash - unspecified	-	-	-	-	-	-	64	64
Ash- Burn pile/hot loads	-	-		-	-	-	3,491	3,491
Ash/Liming Agent - Other	-	-		5,510	-	-	-	5,510
Carpet Fiber and Padding	-	-	25	-	-	-		25
Catch basin grit and street sweepings	-	-	14,259	-	-	-	1,636	15,895
Contam. Soils – contam. unknown	-	-	-	-	-	-	17,547	17,547
Contam. Soils - non-petroleum	-	-	-	-	-	-	16,636	16,636
Contaminated soils - Oil	-	-	29,019	-	-	-	8,067	37,086
Dredge Spoils	-	-	35,340	-	-	-	-	35,340
Fish/Food Process Residue	7,895	-	2,038	41,347	1,458	-	831	53,569
Industrial/Industrial Process Waste	-	-	425	-	-	-	13,297	13,722
Other Special Wastes	-	4	-	-		5,016	33,748	38,768
Pulp/Papermill Sludge	3,664	4,631	57,355	-	-	-	2,770	68,419
Sandblast Grit	-	-	2,215	-	-	-	268	2,483
Short-Paper Fiber	-	-	39,174	2,050	-	-	21,686	62,910
Shredder Residue	-	-	-	-	-	-	27,814	27,814
WWTP Sludge - industrial		-	-	12	-	-	78,197	78,209
WWTP Sludge - municipal	41,339	-	-	1,975	-	-	47,914	91,228
Totals	**61,752**	**4,635**	**199,907**	**77,538**	**1,458**	**5,016**	**537,545**	**887,850**

*N-Viro is a company located in Maine that utilizes a conversion process for treatment of sludge

V. Solid Waste Disposal Capacity

In 2014, Maine's solid waste disposal facilities included three waste-to-energy (WTE) facilities, seven municipally-owned landfills, two state-owned landfills, and one commercially owned landfill. The State has another licensed landfill site, known as Carpenter Ridge, located in T2 R8, that remains undeveloped. That site, with a landfill design for approximately two million cubic yards of special wastes, was acquired by the State in the mid-1990's and has been held by the State for development of disposal capacity when it is needed. The state-owned Dolby Landfill, located in East Millinocket, accepted minimal amounts of solid waste in 2014, and due to environmental and fiscal considerations, is slated to cease operations in 2016.

The Department receives landfill capacity estimates from each of the public and commercial disposal facilities, and annual reports of the types and amounts of waste being disposed at each facility. Based on the data in these reports, the Department projects the amount of waste expected to be disposed over time (using current disposal rates) and estimates the projected remaining life span of each facility.

Landfills receive a variety of wastes. The types of wastes permitted for disposal differ among the facilities, as requested in their licensing applications. This report focuses on municipal solid waste, including construction and demolition debris, as well as the residues from the processing of those wastes. However, in projecting the consumption of landfill capacity, the Department combined the tonnages of the various cover materials and the other special wastes that were landfilled, along with the municipal solid waste tonnages, to estimate the remaining life of the landfills since all these waste types consume landfill capacity. For that reason, those wastes and their impact on landfill capacity are included in this report.

Table 4 shows the current and projected available Waste-to-Energy processing and Landfill disposal capacity in Maine, by licensed facility, through 2034. In 2014, 1,308,189 cubic yards of landfill capacity were consumed in Maine by MSW (257,706 tons), CDD (462,036 tons), and special wastes (394,584 tons), and 369,549 tons of MSW were destroyed through combustion. This 1,483,875 tons of waste disposed of in Maine included waste from out-of-state sources as well as wastes from Maine. Maine-generated MSW, CDD and special wastes sent for disposal 2014 totaled 1,437,362 tons, not including special wastes disposed of in generator owned landfills affiliated with specific industrial facilities. This includes 145,809 tons of special waste into commercial and state-owned landfills in Maine, and 78,863 tons of MSW & CDD disposed of out of state.

Table 4 - Available Licensed MSW Disposal Capacity in Maine

Waste-to-Energy Facilities (W-T-E)	Annual capacity	2014 (tons/year)	2019 (tons/year)	2024 (tons/year)	2034 (tons/year)
MMWAC – Auburn	70,000	70,000	70,000	70,000	70,000
ecomaine – Portland	170,000	170,000	170,000	170,000	170,000
PERC – Orrington	304,000	304,000	304,000	304,000	304,000
Total Waste-to-Energy Facility capacity in tons	**544,000**	**544,000**	**544,000**	**544,000**	**544,000**

	2014 Fill rate (yd^3)	*2014 available (yd^3)*	*2019 available (yd^3)*	*2024 available (yd^3)*	*2034 available (yd^3)*
State-owned landfills					
Carpenter Ridge – T 2 R 8	N/A	not developed	Assumed not developed	Assumed not developed	Assumed not developed
Dolby – East Millinocket	141	398,000	0 (closed)	0 (closed)	0 (closed)
Juniper Ridge – Old Town	733,400	3,903,600	236,600	0	0
Municipal MSW landfills					
Hatch Hill (Augusta)	59,500	867,600	570,100	272,600	0
Bath	31,500	295,300	137,800	0	0
Brunswick	9,600	207,137	159,137	111,137	15,137
Presque Isle	14,508	1,429,441	1,356,901	1,284,361	1,139,281
Tri-Community (Fort Fairfield)	34,594	1,634,891	1,461,921	1,288,951	943,011
W-T-E ash landfills					
ecomaine	62,824	684,775	370,655	56,535	0
Lewiston	17,959	557,065	467,270	377,475	197,885
Commercial landfill					
Waste Management Crossroads - Norridgewock	304,109	3,107,865	1,587,320	66,775	0
Total landfill capacity in cubic yards	-	**13,085,674**	**6,347,704**	**3,457,834**	**2,295,314**
Total remaining landfill capacity in tons (MSW)*	-	**10,468,539**	**5,078,163**	**2,766,267**	**1,836,251**

*Average weight of 1 cubic yard of landfilled MSW =1500 pounds, and all remaining licensed landfill capacity will be used for MSW

Based on the current operations of the licensed disposal facilities, the Department projects that the disposal capacity for MSW (including CDD) generated in Maine will remain adequate into the foreseeable future. Management of out-of-state generated waste can be provided by the waste-to-energy facilities and the commercially owned landfill, but not by state-owned disposal facilities.

The Department is currently considering two solid waste processing/disposal facility applications that, if approved and constructed, will add additional solid waste management capacity in Maine. The projections considered in this report do not take into account this proposed capacity.

Table 5 shows the types and amounts of solid wastes delivered to the various disposal facilities in 2014, and shows the estimate of remaining disposal capacity in cubic yards and years.

TABLE 5 - 2014 Solid Waste Tonnage that was Landfilled, and Remaining Landfill Capacity (as of December 31, 2014)							
Landfill	**MSW (tons)**	**CDD (tons)**	**Special Wastes (tons)**	**Capacity Consumed in 2014 (cubic yards)**	**Constructed Capacity Remaining (cubic yards)**	**Licensed Capacity Remaining (cubic yards)**	**Years of Licensed Capacity Remaining at current fill rate**
Hatch Hill (Augusta)	27,917	(included in MSW)	7,931	59,500	867,600	867,600	14.6
Bath	13,528	1,169	880	31,500	81,300	295,300	9.4
Brunswick	4,302	(included in MSW)	0	9,600	207,137	207,137	21.6
Presque Isle	7,715	1,470	2,919	14,508	239,441	1,429,441	98.5
Tri-Community	15,717	1,939	2,046	34,594	513,241	1,634,891	47.3
ecomaine	11,460	0	48,837	62,824	106,865	684,775	10.9
Lewiston	0	541	17,325	17,959	557,065	557,065	31.0
Waste Management / Crossroads	81,533	65,130	153,776	304,109	3,107,865	3,107,865	10.2
Juniper Ridge	95,534	373,820	159,579	733,400	995,000	3,903,600	5.3
MidCoast Solid Waste Corporation	0	1,097	46	2,131	26,523	26,523	12.4
Rockland	0	16,870	1,245	36,064	147,300	147,300	4.1
TOTALS	**257,706**	**462,036**	**394,584**	**1,306,189**	**6,849,337**	**12,861,497**	--

Table 6, below, shows the source of the MSW received by each of the three Waste-to-Energy Facilities, and how that waste was managed, including the various residue streams created.

Table 6 - 2014 MSW Handled by Maine Waste-to-Energy Facilities (in tons)

Facility	Municipally Delivered MSW received	Commercially Delivered MSW received	Spot market MSW received	Other wastes received	Total waste received	Waste shipped as by-pass	Front end process residue produced	Metals recovered	MSW combusted	Ash	MSW destroyed through combustion
ecomaine	66,588	75,207	40,149	2,836	184,780	6,328	--	4,810	172,656	44,178	128,478
Mid Maine Waste Action Corporation	38,205	14,671	22,848	0	75,724	5,684	--	1,963	69,509	17,226	52,283
Penobscot Energy Recovery Company	192,720	108,488	11,106	5,164	317,479	1,613	57,828	8,016	242,822	54,034	188,788
TOTALS	**297,513**	**198,366**	**74,103**	**8,000**	**577,983**	**13,625**	**57,828**	**14,789**	**484,987**	**115,438**	**369,549**

Table 7, below, shows the state's source of generation of the MSW which was received by each of the three Waste-to-Energy Facilities.

Table 7 – Tons of MSW Received at Waste-to-Energy Facilities - - by State of Origin

Facility	Maine	MA	NH	Total Tons		% Maine	% MA	% NH
ecomaine	162,269	--	6,771	169,040		96.0%	0.0%	4.0%
Mid Maine Waste Action Corporation	75,586	--	138	75,724		99.8%	0.0%	0.2%
Penobscot Energy Recovery Corporation	260,931	50,060	1,324	312,315		83.6%	16.0%	0.4%
Totals	**498,786**	**50,060**	**8,233**	**557,079**		**89.5%**	**9.0%**	**1.5%**

VI. Solid Waste Industry Consolidation in 2014

The Waste Generation and Disposal Capacity Report includes an analysis of consolidation in the ownership of the collection, recycling, hauling, and disposal sectors. This is performed to review Maine's solid waste industry for possible undue consolidation and the potential for unfavorable impacts on competition. The Department examines these industry sectors for conditions that may either create a decrease in services or a monopolistic situation.

During 2014, Maine's solid waste (aka, 'materials management') industry continued to be a mix of public and private investments and services that handled over 7,500 tons of materials each day. A review of that system and its components shows that the interrelated services of collection and hauling of recyclables and trash, and the processing or disposal of those materials, were provided in a consistent fashion, responding to Maine's solid waste management needs.

Disposal Facilities

During 2014, there were no noted changes in the ownership/operation of the licensed disposal facilities in Maine.

Collection and Hauling Services

Since the last Waste Generation and Disposal Capacity Report, the Department has learned that three smaller sized hauling services companies (each with less than five collection vehicles) were acquired by three separate larger hauling companies: two were as the result of changes in company leadership and one was a purchase to obtain a permanent presence in a different service area.

Recycling Services

In 2014, Casella Waste Services, Inc., in partnership with the City of Lewiston, converted the city's recycling facility into a 'Zero Sort®' materials processing facility and began processing recyclables from the City and other municipalities. This is the second 'materials recovery facility' (MRF) serving Maine's municipalities and businesses; the other MRF is owned and operated by ecomaine, a non-profit waste management company owned by 21 municipalities in Southern Maine.

The Department has a noted a move by many municipalities to adopt a single stream/single-sort/ZeroSort® recycling program, which has led to the abandonment of long established 'source separated' recycling programs and facilities that had successfully been baling and marketing recyclables for many years.

VII. Disposal Fees and Supracompetitive Prices

Disposal Fees

Disposal expenses are comprised of collection and transportation costs, and tipping fees on the disposal of waste at a facility. Disposal fees or tipping fees are a major factor in solid waste management costs for municipalities and businesses. Current tipping fees range from $40 to $95 per ton at Maine's transfer stations, waste-to-energy facilities and landfills. These have stabilized in most instances, allowing predictability for municipal budgeting and long-term planning.

Tipping fees at two of the three waste-to-energy facilities have undergone various alterations in recent years, with ecomaine reducing their tipping fee at their waste-to energy facility, and the Penobscot Energy Recovery Company (PERC) raising their tipping fee[4].

The State, in its operating services agreement with Casella Waste Systems Inc., established a ceiling for tipping fees that set an upper limit on how much can be charged for various categories of wastes delivered to the Juniper Ridge Landfill, which has had a stabilizing impact on pricing for the disposal of similar materials at other solid waste facilities.

Tipping fees at waste-to-energy facilities are influenced by revenues received from the sale of the electricity they generate. The revenues reduce operating expenses, yielding a reduction in the tip fee charged for solid waste. Should electricity sales revenue drop, tipping fees may increase. Conversely, should the electricity sales value increase, the possibility exists that lower tipping fees, or maintaining current fees, would occur.

Supracompetitive Prices

Supracompetitive, as applied to 'prices,' means prices that are higher than they would be in a normally functioning, competitive market; usually as a result of overconcentration, collusion, or some form of monopolistic, oppressive practice. State law requires the Department to determine whether changes in available landfill capacity have generated, or have the potential to generate, supracompetitive prices and if so, provide recommendations for legislative or regulatory changes as necessary.

[4] *Note: the Municipal Review Committee (MRC) represents 187 Maine municipalities that ship their MSW to PERC for disposal and provides a tipping fee reduction program to MRC's charter members.*

Disposal capacity at Maine landfills is sufficient to meet current needs. At the time of this report, the disposal capacity situation does not appear to have generated, nor does it appear in the near term to have the potential to generate, supracompetitive disposal fees. In looking ahead, however, at that point when disposal capacity exists with fewer facilities than today, it is possible that prices will become supracompetitive. Where the actual date and timing of this is not known, nor predictable, it is critical that the Department maintains a firm awareness of this possibility and keeps the Governor and Legislature informed.

Appendix A - Definitions and Acronyms

The following definitions and acronyms are provided to assist the reader in reviewing this document:

Beneficial Use – *to use or reuse a solid waste or waste derived product: as a raw material substitute in manufacturing, as construction material or construction fill, as fuel, or in agronomic utilization.*

Bulky Wastes – *solid wastes that do not typically fit into a 30 gallon trash container, and may include such items as wood, large metal appliances and construction materials.*

Construction/Demolition Debris (CDD) – *wastes generated by building, remodeling and/or destruction activities and may include such wastes as wood and wood products, concrete and brick, gypsum board, shingles and other common components of buildings.*

Department – *Maine Department of Environmental Protection*

Diversion Rate – *Waste diversion is the prevention and reduction of generated waste through source reduction, recycling, reuse (including beneficial reuse), or composting.*

Front-end Process Residue (FEPR) – *residual of municipal solid waste resulting from the processing of solid waste prior to incineration or landfilling, and includes, but is not limited to, ferrous metals, glass, grit and fine organic matter.*

Municipal Solid Waste (MSW) – *solid waste emanating from household and normal commercial activities.*

Special Solid Waste – *wastes that are generated by other than domestic and typical commercial establishments that exist in such an unusual quantity or in such a chemical or physical state that require special handling, transportation and disposal procedures.*

Supracompetitive – *when applied to prices means prices that are higher than they would be in a normally functioning, competitive market -- usually as a result of overconcentration, collusion or some form of monopolistic, oppressive practice.*

Universal Wastes – *a category of wastes that includes: PCB containing lighting ballasts, Cathode Ray Tube (CRT) containing devices, fluorescent lamps, other lamps containing hazardous wastes, and, mercury-added devices from commercial sources.*

Waste-to-Energy Ash – *residue from the combustion of municipal solid waste at waste-to-energy facilities. It may also contain fly ash from the facility's operation and is designated as a "special solid waste".*

Waste-to-Energy facilities (W-T-E) – *facilities which receive municipal solid waste, and through processing and combustion, recover energy and convert it into electricity, while reducing the volume of waste requiring disposal.*

Appendix B – Fact Sheet Presented to the Northeast Committee on the Environment

Fact Sheet

Presented to the Northeast Committee on the Environment Challenges Facing Municipal Solid Waste (MSW) Recycling in the Northeast at their November 9, 2015 meeting

Prepared by the Northeast Waste Management Officials' Association (NEWMOA) and the Northeast Recycling Council (NERC)
November 2015

(Presented here with permission from NEWMOA & NERC)

This fact sheet identifies some of the challenges facing MSW residential recycling programs in the northeast. It describes the overall economic benefits of recycling for the region and focuses on paper, glass, and plastic as key materials that are challenging for the materials recovery facilities (MRFs) to process economically. It focuses on paper, glass, and plastics because they present some of the most difficult challenges for today's MRFs.

Background
The overall U.S MSW recycling rate was approximately 34 percent for 2013, according to EPA.[5] In many locations, municipal recycling programs focus on paper, plastic, glass, and metal. There are significant differences in the materials collected in various locations.

States in the northeast use inconsistent approaches for estimating recycling, and many agency staff report low confidence in the available data. Solid waste program staff have reported greater confidence in the disposal data that they collect from permitted facilities. Because of data challenges, this fact sheet does not present or compare the states' recycling rates.

Economics of Recycling
Recycled materials are part of an international marketplace, and many factors impact them. Some of these contribute to market volatility, including the price of oil; the price of virgin resin; the value of the U.S. dollar; China's Green Fence; the economies of foreign markets; and communication among the U.S. MRFs, brokers, processors, and manufacturers about the industry's changing needs.

[5] http://www2.epa.gov/smm/advancing-sustainable-materials-management-facts-and-figures

According to the Institute of Scrap Recycling Industries (ISRI), the total number of jobs created directly and indirectly (through suppliers and related jobs) through recycling of scrap metals, plastics, textiles, glass, and electronics in the seven states in CONEG is approximately 41,777. This translates to more than $9.5 million in wages and taxes.[6]

Changing Materials in the Recycling Stream

The composition of MSW has been evolving in recent years with less newsprint, glass, aluminum, steel packaging, paper board, and paper packaging and more aluminum foil and closures, corrugated card, high-density polyethylene (HDPE) bottles and other containers, polyethylene terephthalate (PET) bottles and jars, and other plastic packaging.

Demand for paper has declined for the past decade. The most dramatic reduction has been in newspaper use. This is due to the increased use of electronic devices. North American newsprint shipments went from 12.7 million metric tons 2005 to 6.4 million metric tons in 2013.[7] Newspaper historically made up 60 percent of the recyclables collected, and all types of paper made up 80 percent of the material recycling facilities received. Today paper makes up just 45-60 percent of incoming material.[8]

Packaging is rapidly changing away from the use of glass and metal toward lighter materials, including multi-layer, multi-resin pouches, plastic packaging, and other types of containers that are either less recyclable or not recyclable. In addition, the plastic that is used for packaging has been light-weighted. For example, plastic makes up approximately 12.7 percent of the incoming recyclables by weight, but over 25 percent by volume. Processing costs are incurred by volume, but revenue is by weight. Therefore, recyclers need to process more material to generate a ton of recyclables.

The changing waste stream means MRFs need to process more volume, with less weight, increasing processing costs.[9] These shifts have been affecting the business models that have dictated the designs of the MRFs.

Trends in Municipal Collection for Recycling

Increasingly in the northeast and elsewhere in the U.S. recycling has transitioned from a dual stream to a single stream system. These programs collect all recyclables, including glass, paper, plastic, and metal in one container. Trash is collected separately. Single stream recycling (SSR) has grown rapidly in the region during the past five years. There were 81 communities in Massachusetts with SSR systems in 2011; by 2014 108 communities had transitioned. In New Hampshire, 38 facilities accepted SSR waste in 2011; by 2014 there were 53 facilities. In most single stream programs, the traditional 18 gallon recycling bin has been replaced by a 64 or 95 gallon cart. Single stream programs typically result in significantly more recyclables being

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[6] http://www.isri.org/docs/default-source/recycling-analysis-%28reports-studies%29/economic-impact-study-u-s-based-scrap-recycling-industry-2015.pdf?sfvrsn=10

[7] April 27, 2015, Dylan de Thomas, Resource Recycling presentation to the Maine Resource Recovery Association

[8] Ibid.

[9] Susan Robinson, Waste Management, November 13, 2014 Presentation, EPA SMM Webinar Academy - http://www2.epa.gov/sites/production/files/2015-09/documents/changng_wste_stream.pdf.

collected due to the convenience for residents and the additional space for a bulky recycling stream. In Massachusetts, increases range from 10 percent to 60 percent (for Boston), depending on the baseline recycling rate in a given community.

With the growth of single stream collection and the use of large containers, is a rise in contamination of the materials. This contamination takes the form of film plastics, Styrofoam, non-recyclable plastic materials being put in the single stream bins; food waste and broken glass contaminating paper; liquids being absorbed into the paper; non-recyclable packaging, and a wide range of other non-recyclable materials. Contamination can drive up costs facing the municipalities and individual customers.

Paper
According to EPA's latest estimates, paper is approximately 27 percent of MSW.[10] Paper collection and recycling focuses in general on newsprint, office, magazines, cardboard, and boxboard. In the NECOE states, there are approximately 61 facilities that process and recycle one or more of these kinds of paper. A list of these facilities is available from the Northeast Recycling Council (NERC).

MRFs sort paper and send it directly to "end use" mills in the U.S. or abroad. Demand for cardboard has increased significantly since 1990 due to the increase in e-commerce shipments of products directly from manufacturers or wholesalers to consumers. Demand for other types of paper has been dropping, particularly newsprint (as noted above.). However, China continues buying U.S. paper. For a number of years, it has been the largest export material from the Port of Boston.

Single-stream recycling has resulted in an increase in "mixed paper" that is low value and often shipped to China. In addition, the liquids and glass present in SSR are absorbed by and stick to the paper, degrading its marketability.

Glass
According to EPA's latest estimates, glass is approximately five percent of MSW.[11] Glass collection and recycling at the curb focuses on mixed colored and clear glass. There is a demand for high-quality glass cullet.[12] In the NECOE states, there are several facilities that are processing and recycling one or more of these kinds of glass. A list of these facilities is available from the Glass Packaging Institute (GPI).

Of the NECOE states, five have bottle bill programs. Glass from these programs is generally clean and is shipped directly to the glass processors (not through MRFs) and then shipped to glass bottle manufacturers.

Some MRFs are no longer able to produce the quality of glass that manufacturers can use. Glass fines often end up mixed with the facility's residue that contains dirt and small-sized paper, plastic, and metal contamination. Due to the low quality product and the high cost of

[10] http://www2.epa.gov/smm/advancing-sustainable-materials-management-facts-and-figures
[11] http://www2.epa.gov/smm/advancing-sustainable-materials-management-facts-and-figures
[12] http://www.gpi.org/; Cullet.net: http://www.cullet.net/cgi-bin/mexview.cgi?wsc=01-0901

transportation, many MRFs face limited markets for their glass, and it ends up as processed glass aggregate and being used for alternative daily cover or shaping and grading materials. Some MRFs have recently started to employ more sophisticated sorting technology that improves the quality of recovered glass or conduct an additional processing step to recover a cleaner glass product from the residue. Encouraging other MRFs to make the similar investments could be an important aspect of addressing this challenge.

Some communities have begun to try to improve the quality of collected glass by adding drop-off locations. A few municipalities are piloting or considering trying this approach by carefully installing drop-offs that are conveniently accessible for residents.

Plastics

According to EPA's latest estimates, plastic is approximately 13 percent of MSW.[13] Collection of plastic for recycling focuses on number 1 polyethylene terephthalate (PET), (e.g. soda bottles, and milk jugs or number 2 high-density polyethylene (HDPE)) because they have the highest value. Many communities also collect numbers 3, 4, 6 and 7, however markets for some of these materials are less prevalent. The markets for number 5 plastic (polypropylene) are growing because of their use in containers, caps, and other packaging. In the NECOE states, there are approximately four facilities that are processing and recycling one or more of these plastics. A list of these facilities is available from the Northeast Recycling Council (NERC).

The Association of Plastic Recyclers[14] is working with MRFs and processors, who convert plastic into useable materials (e.g., pellets) and sell it to end users, on some initiatives to help smooth out market fluctuations for recycled plastics. These include creating specifications for new types of materials to ensure that end users for those materials obtain what they can use.

Education & Outreach

SSR programs provide large bins to residents for collection of recyclables. This has greatly increased the amount of material that programs are collecting. However, the education of residents in the programs has not kept up.

In general, municipalities communicate with households about what is recyclable at the curb or transfer stations. People are often confused about what to put in their SSR bins. The changes in the waste streams described above have added to this confusion. Residents include materials that they "wish" were recyclable. In a recent MassDEP market research survey, 48 percent of respondents characterize themselves as "wishful recyclers", meaning they put items in the recycling bin that the MRF is not designed to sort and recover, such as plastic bags, Styrofoam, large metal objects, textiles and garden hoses.[15] The researchers concluded that while the public believes they are doing a good job recycling, it's easy, and they know the rules, in fact they are misinformed and do not know the rules. A lesson from this study is that state programs and municipalities need to do a better job recalibrating the public's understanding of what can and

[13] http://www2.epa.gov/smm/advancing-sustainable-materials-management-facts-and-figures
[14] http://www.plasticsrecycling.org/
[15] http://www.mass.gov/eea/docs/dep/public/committee-4/recpart15.pdf

cannot be recycled in the bin, while being careful not to discourage people or make them feel that the programs are slapping their hands.

Depending on the location, neighboring cities and towns may have different wastes that they collect for recycling. Anecdotally, it appears as though the investment in recycling education programs has been in decline in many locations in the region, and creating cross-community education programs is challenging since the collection systems differ. Many recycling coordinators think that their programs have neglected education in recent years. Massachusetts DEP ended its recycling education grants for municipalities in 2007. Prior to that, the Agency spent about a half million dollars per year printing and mailing customized recycling flyers for about two million households. The SSR carts include a label on the top with pictures of what and what not to put in, which provides some guidance, but for many communities there is not much more outreach underway.

Some municipal recycling and state programs in the region have recently launched public education campaigns combined with greater enforcement, which could provide models for others. The Recycling Partnership (www.recyclingpartnership.org), Waste Management ("Recycle Often. Recycle Right" www.recycleoftenrecycleright.com), and Keep America Beautiful have also launched public education campaigns to address the challenges outlined above and others.

Appendix C - Status of Northeast States' Product Stewardship Laws

Status of Northeast States' Product Stewardship Laws
November 2015

Briefing Report for the Northeast Committee on the Environment
Prepared by the Northeast Waste Management Officials' Association's (NEWMOA) Extended Producer Responsibility (EPR) Implementation Workgroup

The following table summarizes the status of EPR legislation enacted in the Northeast.

Summary of Enacted Legislation

States	**CT**	**ME**	**MA**	**NH**	**NY**	**RI**	**VT**
Products							
Electronics	✓	✓			✓	✓	✓
Paint	✓	✓				✓	✓
Thermostats	✓	✓	✓	✓	✓	✓	✓
Auto switches		✓	✓			✓	✓
Lamps		✓					✓
Rechargeable batteries	?	✓			✓		
Primary batteries							✓
Mattresses	✓					✓	
Framework		✓					
Bottle Bill*	✓	✓	✓		✓		✓

*Some state officials', but not all, view bottle bills as a form of EPR legislation so it is included in this table.

Overview of Findings on Impacts of EPR Programs in the Northeast

<u>Connecticut DEEP</u> is conducting an evaluation of the impacts of its e-waste EPR program in the State and overall has found:

- In 2014, there were 273 permanent collection sites for covered e-waste
- More than 18 million pounds of e-waste was collected in 2014 through the program; the quantity has increased each year since 2011

- Per capita e-waste collected has increased since the program began and was 5.16 pounds/year/person in 2014
- In 2013 and 2014 more than 50 percent of generated CT household e-waste was collected
- In 2014, the amount of covered electronics that was recycled was more than 14.5 million pounds, representing 86 percent of the collected material
- The greenhouse gas savings in 2013 and 2014 was more than 8.5 million kilograms of carbon equivalents each year
- The total number of jobs created in the State between the start of the program and 2014 was 41
- The avoided municipal disposal costs for 2014 was more than $500K; these costs have increased each year since the start of the program

In two years, the paint EPR program in CT has collected more than 500,000 gallons of paint. 80 percent of the latex is recycled into new paint.

Maine DEP is conducting an evaluation of the impacts of its e-waste EPR program and overall has found (www.maine.gov/dep/commissioners-office/kpi/details.html?id=586531):

- The program collected more than 8.4 million pounds of e-waste in 2014; the quantity has increased each year since 2011
- Approximately, 3.4 million pounds of e-waste was handled outside of the ME EPR program in 2014; the major handlers were consolidators, Goodwill, and retailers
- The amount of per capita e-waste collected through the EPR program and outside of the program has grown each year since 2011; in 2014 approximately 6.4 pounds/person was collected through the EPR program
- E-waste handlers have informally reported creating more than 40 jobs in Maine as a result of the EPR program

New York State DEC has analyzed the results of its e-waste program as of 2014 and found:

- There are 95 registered manufacturers
- There are 1300+ registered recyclers, consolidators, and collectors
- More than 325 million pounds of total e-waste was collected since inception of the e-waste law
- In 2015 manufacturers are mandated to collect approximately 97 million pounds of total e-waste

DEC is working with a contractor, ReTrac to develop an electronic reporting system for all e-waste entities within the program. DEC is developing regulation and holding stakeholder meetings to solicit input.

Rhode Island DEM has compiled results for their EPR programs. In 2014, the e-waste program had:

- 58 approved manufacturers
- 35 permanent collection locations and 36 seasonal/temporary collection locations
- 4.97 pounds per capita of covered products collected

The RI mercury thermostats program collected:

- 2,618 mercury-added thermostats (18.27 pounds of mercury) in 2013
- 2,720 mercury-added thermostats (23.43 pounds of mercury) in 2014

Collections of whole thermostats increased in Rhode Island by 7 percent in 2014, following a 53 percent increase in 2013. Out of 13 mandatory programs in the U.S., RI's participation rate ranks first with over 60 percent of the Thermostat Recycling Corporation collection locations returning one or more containers in 2014.

In 2014, the RI auto switch collection program collected 4,298 switches. RI has consistently ranked at the top for percent switches recovered.

The RI paint collection program began on June 1, 2014.The program processed 64,525 gallons of postconsumer paint during its first year. Latex paint made up 62 percent of the total paint; 87 percent was made into recycled content paint, and 13 percent was unrecyclable and sent to landfill. Oil-based paint made up 38 percent of the total paint. All of it was used as fuel. In addition, 27 tons of metal and plastic containers were recycled.

Vermont DEC regularly analyzes the impacts of the State's e-waste EPR program and identifies opportunities for improvement. The following are results for October 1, 2014 to September 30, 2015:

- 95 permanent collection sites and 83 manufacturers registered
- State Standard Program and one Opt-out Program in Program Year 4 operated (the majority of the collection sites were shared by both programs and the total pounds collected by the recycler from those shared sites were allocated according to percentage of participating manufacturers in each program)
- Over 4.6 million pounds or 7.34 pounds per capita collected, (statewide performance goal was 4,632,991 pounds)
- 13 collection events were held at various locations across the State to supplement the permanent collection locations

Proposed Legislation

There continues to be legislation introduced in some states, mostly by interested stakeholders, to advance EPR for certain product categories. This proposed legislation for 2015 is summarized below.

Bills Proposed for Targeted Products in 2015

States	CT	ME	MA	NH	NY	RI	VT
Products							
Electronics			•				
Paint			•		•		
Tires	•						•
Auto switches					•		
Lamps					•	•	
All batteries	•				•		
Pharmaceuticals			•			•	
Smoke Detectors					•		
Framework			•				
Bottle Bills	•	•	•			•	•

BGS/NEWSME 64

06-096

Department of Environmental Protection

Maine Solid Waste Management Rules

CHAPTER 400

GENERAL PROVISIONS

Last Revised:

July 20, 2010

(3) A solid waste facility owned by a refuse disposal district under chapter 17 as long as the refuse disposal district controls the decisions regarding the type and source of waste that is accepted, handled, treated and disposed of at the facility;

(4) A solid waste facility owned and controlled by the office under chapter 24;

(5) A solid waste facility owned and controlled by a single entity that generates at least 85% of the solid waste disposed of at the facility, except that the facility may accept from other sources, on a nonprofit basis, an amount of solid waste that is no more than 15% of all solid waste accepted on an annual basis. For purposes of this paragraph, "single entity" means an individual, partnership, corporation or limited liability company that is not engaged primarily in the business of treating or disposing of solid waste or special waste. This paragraph does not apply if an individual partner, shareholder, member or other ownership interest in the single entity disposes of waste in the solid waste facility. A waste facility receiving ash resulting from the combustion of municipal solid waste or refuse-derived fuel is not exempt from this subsection solely by operation of this paragraph; or

(6) A private corporation that accepts material-separated refuse-derived fuel as a supplemental fuel and does not burn waste other than its own.

AA. *(Reserved)*

BB. Commercial waste. "Commercial waste" means solid waste generated by stores, offices, restaurants, warehouses, and other non-manufacturing, non-processing activities. Commercial waste does not include household, process, industrial or special wastes.

CC. Composite liner. "Composite liner" means a geomembrane placed over and in direct and uniform contact with a barrier soil layer and/or geosynthetic clay liner, without a leak detection or leachate collection layer between them.

DD. Compost. "Compost" means a residual that has undergone a composting process.

DD-1. Compost Management Plan. “Compost Management Plan” means a plan developed by an Agricultural Composting Operation to demonstrate compliance with the Department of Agriculture, Food and Rural Resources’ best management practices for Agricultural Composting Operations.

EE. Composting. "Composting" means the biological decomposition of organic residuals under predominantly aerobic conditions and controlled temperatures between 110° and 160° F.

EE-1. Composting Facility. “Composting facility” means any land area, structure, equipment, machine, device, system, or combination thereof, which is operated to facilitate the composting of solid waste.

FF. Construction or demolition debris. "Construction or demolition debris" means solid waste resulting from construction, remodeling, repair, and demolition of structures. It includes but is not limited to: building materials, discarded furniture, asphalt, wall board, pipes, and metal conduits. It excludes: partially filled containers of glues, tars, solvents, resins, paints, or caulking compounds; friable asbestos; and other special wastes.

GG. Construction Fill. "Construction Fill" means fill that may contain solid waste utilized to provide material for construction projects such as roads, parking lots, buildings or other structures. It does not include fill needed to re-contour an area within a landfill or where no further construction is occurring. If the construction fill contains solid waste other than inert fill, the use of the fill is regulated under Chapter 418.

HH. Contamination or Pollution

(1) As applied to ground water, "contamination" or "pollution" means exceeding water quality standards, the concentrations of which are attributable to the solid waste facility, as:

(a) Specified in CMR 231 - Primary Drinking Water Standards, promulgated pursuant to 22 M.R.S.A. section 2611; or

(b) Demonstrated by a statistically significant change in measured parameters which indicates deterioration of water quality determined through assessment monitoring.

(2) As applied to surface water, "contamination" or "pollution" means an unlicensed discharge to a classified body of surface water that is not exempt from licensing and is attributable to any aspect of the solid waste facility operation.

II. Crop for direct human consumption. "Crop for direct human consumption" means a food crop that is distributed to consumers without prior processing such as blanching, frying or cooking to minimize pathogens.

JJ. Daytime hours. "Daytime hours" means the hours between 7:00 a.m. and 7:00 p.m.

KK. Demolition debris. See "construction or demolition debris".

LL. Department. “Department" means the Department of Environmental Protection composed of the Board of Environmental Protection and the Commissioner.

MM. Department Supervised Clean-up. “Department Supervised Clean-up" means a clean-up of oil contaminated soil that is undertaken under the direction of a representative of the Department.

NN. Design leakage rate. “Design leakage rate" means the amount of leakage expected through the liner system(s) within the solid waste boundary, plus an additional amount of leakage from waste handling areas, to account for factors such as changes in long-term performance of engineered products, operational considerations, and site-specific design features. The design leakage rate includes leakage during the operational, closure, and post-closure periods.

OO. Detection monitoring. “Detection monitoring" means monitoring conducted periodically throughout the active life of the facility, and through the closure and post-closure periods, to detect changes in water quality.

ponds or rivers, streams or brooks, as these terms are defined in 38 MRSA section 480-B of the Natural Resources Protection Act.

Kk. Public entity. "Public entity" means a municipality or group of municipalities, a public waste disposal corporation under 38 MRSA section 1304-B, a refuse disposal district under 38 MRSA section 1702, *et seq*., a county, State or Federal agency.

Ll. Public viewing area. "Public viewing area" means an area designated for the public to view scenic areas, historical sites, unusual natural features or public monuments. These areas include but are not limited to scenic highways; public easements; scenic turnouts; public monuments; and national, state or municipal parks.

Mm. Pug mill. "Pug mill" means any lined mixing chamber that uses an emulsified or cut-back asphalt binding agent to produce a bituminous product from an aggregate.

Nn. Putrescible Waste. "Putrescible waste" means solid waste that contains organic matter that can be rapidly decomposed by microorganisms, which may give rise to foul smelling, offensive products during such decomposition or which is capable of attracting or providing food for birds and potential disease carrying organisms such as rodents and flies.

Oo. Quantifiable noise standard. "Quantifiable noise standard" means a numerical limit governing noise that has been duly enacted by ordinance by the municipality.

Pp. R.C.R.A. "R.C.R.A." means the Resource Conservation and Recovery Act, 42 U.S.C.A. section 6901 *et seq.*

Qq. Recycle/Recycling. "Recycle" and "Recycling" means the collection, separation, recovery and sale or reuse of materials that would otherwise be disposed of or processed as waste or the mechanized separation of waste, other than through combustion, and the creation and recovery of reusable materials other than as a fuel for the generation of electricity.

Rr. Refuse-derived fuel. "Refuse-derived fuel" means municipal solid waste which has been processed prior to combustion to increase the heat input value of the waste.

Ss. Residual. "Residual" means solid wastes generated from municipal, commercial or industrial facilities that may be suitable for agronomic utilization. These materials may include: food, fiber, vegetable and fish processing wastes; dredge materials; sludges; dewatered septage; and ash from wood or sludge fired boilers.

Tt. Residue. "Residue" means waste generated as a result of the handling, processing, composting, incineration, or recycling of solid waste including, without limitation, front end process residue, fines and other residues from construction demolition debris processing facilities, and ash from incineration facilities and non-compostable compost screenings.

Uu. Routine operation. "Routine operation" means, for the purpose of regulating noise, the regular and recurrent operation of a solid waste facility and the sound sources associated with that operation .

BGS/NEWSME 65

PICK-UP AUTHORIZATION AND DISPOSAL RECEIPT

JUNIPER RIDGE LANDFILL

Operated By NEWSME Landfill Operations, LLC
2828 Bennoch Road, Old Town, ME 04468
207-394-4372

DATE: 08/25/2016 TICKET: 294914
PROFILE: 3432

CUSTOMER:
PERC
29 INDUSTRIAL WAY
ORRINGTON , ME 04474

CUSTOMER NO.:
L G 00004

CONTACT:
GARY

TELEPHONE NO.:
(207) 825 - 4566

P.O./MANIFEST: 107354

GENERATOR: PERC
ORRINGTON , ME

MATERIAL:
M UNICIPAL ASH

TRANSPORTER:
KB CORP
Truck#: 76 Trailer#: 509

AREA:
OLD TOWN LANDFILL

Ticket#: 294914

WEIGHT		COMMENTS	
GROSS	95840	CUBIC YARDS	
TARE	32360	TIME IN	07:36
NET WT.	63480	TIME OUT	07:37

I certify to the best of my ability, that the above name materials are properly classified, described, packaged, and identified, and are acceptable for disposal in accordance with the waste acceptance criteria for the Juniper Ridge Landfill. I agree to abide by the applicable waste and driver criteria, policies, and procedures, and understand that copies of such will be made available to me upon request.

Driver's Signature: Brenda

Disposal - Number of tons 31.74 @ $ ________ per ton = $ ________

Disposal - Number of yards ________ @ $ ________ per yd. = $ ________

Weighmaster ________

JAKE BRAKE USED ONLY WHEN NEEDED

"We help keep Maine beautiful"

BILLING-O.M.

BGS/NEWSME 66

JUNIPER RIDGE LANDFILL

Operated By
NEWSME Landfill Operations, LLC

August 1, 2016

Kathleen E. Tarbuck. P.E.
Senior Environmental Engineer
Division of Technical Services
Bureau of Remediation and Waste Management
Maine Department of Environmental Protection
17 State House Station
Augusta, Maine 04333-0017

Dear Ms. Tarbuck:

This letter is in response to your July 15, 2016 email to Tom Doyle requesting a breakdown of OBW quantities received at the Juniper Ridge Landfill by generator name and year. Attached with this letter is the requested information from 2010 through 2015.

Sincerely,

Donald Meagher
Manager of Planning and Development

Cc: JRL Expansion Service List

2828 Bennoch Road • Old Town, Maine 04468
Tel.: 207-862-4200, ext. 245 • Fax: 207-862-2839

Historical Disposal of Over-Sized Bulky Waste (OBW) at Juniper Ridge Landfill

Year	Generator	Tons	Generator	Tons	Generator	Tons	Generator	Tons	TOTAL
2010	KTI BIOFUELS	95,121	MERC	1,346	PERC	52	--	--	96,519
2011	KTI BIOFUELS	97,584	MERC	1,129	PERC	174	--	--	98,887
2012	KTI BIOFUELS	62,945	MERC	1,700	PERC	44	--	--	64,689
2013	KTI BIOFUELS	29,873	MERC	126	PERC	24	RE-ENERGY	24,330	54,353
2014	--	--	--	--	--	--	RE-ENERGY	48,219	48,219
2015	--	--	--	--	--	--	RE-ENERGY	47,388	47,388

BGS/NEWSME 67

COMPLAINT RECORD FORM

JUNIPER RIDGE LANDFILL

-THIS SECTION COMPLETED BY SCALEHOUSE-

Complaint received by the following method: ☐ Phone ☐ Email ☐ Fax ☐ In Person

Complaint received at: ☐ 394-4376 (JRL 24-hour line) ☐ 394-4370 (fax)
☐ 941-4580 (MDEP) ☐ kathy.tarbuck@maine.gov (MEDEP)

Date of complaint: ______________ Time of call/fax/visit: _____________ ☐ AM ☐ PM

Name of person filing complaint: ______________________________

Address: ____

Telephone number: ___________________________________

Nature of complaint: ☐ Odor ☐ Noise ☐ Lights ☐ Dust ☐ Traffic ☐ Other
☐ Traffic- Name of Company_______________ License#__________ Route__________
Direction traveling_________ Truck type ☐ tractor trailer ☐ straight/dump trailer
☐ No Specific Information
For odor complaints; time odor was detected:____________ ☐ AM ☐ PM

Is the odor being detected at the caller's residence? ☐ Yes ☐ No

Telephone call requested? ☐ Yes ☐ No

Site visit requested? ☐ Yes ☐ No

Wind direction & speed at time of complaint: From the __________ @ _____mph

Manager contacted regarding this complaint: _____________________Time:________________

Comments and/or Odor Type: ☐ Sludge ☐ Trash ☐ Rotten Eggs (H_2S) ☐ Other (Specify)

____

____

Scalehouse Attendant Taking Call: ________________Time Faxed to Jeremy Labbe:________________

Complaint Log Number: _________

-THIS SECTION COMPLETED BY RESPONSE PERSONNEL-

Wind direction & speed at time of visit: From the ___________ @ _________mph

Telephone called returned by: _________________________ Date: ____________ Time:____________

Site visited by: __________________________ Date: _______________ Time:_______________

If odor present: Butanol level: _______ Potential Source: ☐ H_2S ☐ Sludge ☐ FEPR ☐ MSW ☐ Other

Specific comments pertaining to complaint:

____

Completed Complaint Record Form entered into the Environmental Audit Database: (Date) ____________________

BGS/NEWSME 68

"ODOR SCHOOL"®

NASAL RANGER®

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Odor Inspector

Odor Assessment & Measurement Certification
For Measuring Ambient Odors (7.5 TCH)

15 July 2009
Juniper Ridge Landfill
Old Town, Maine

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www.fivesenses.com & www.nasalranger.com