Save the River-Save the Hills, Inc.
P.O. Box 505
Waterford, CT 06385

February 17, 2020

Mr. Chris Stone, PE
CT DEEP
79 Elm Street
Hartford, Connecticut 06106-5127

RE: Proposed Stormwater Requirements for Ground Mounted Solar Arrays

Dear Mr. Stone:

Save the River-Save the Hill, Inc., is a Waterford, CT based grassroots environmental organization with the mission of preserving the health of the Niantic River Estuary and its surrounding hills. We appreciate the opportunity and respectfully submit our comments on the DEEP Stormwater Regulation updates entitled "Appendix I Stormwater Management at Solar Array Construction Projects".

First, STR-STH would like to put the changes in historical perspective. Since the Industrial Revolution our country and state have equated "Progress" to building and development – dominion over nature. The drum beat was strong and our country and state have created many products and projects useful to civilization. The by-products, pollution and adverse effects of development have accumulated and in our current climate (pun intended) nature is signaling it is time to change our approach. Progress should no longer look like development at all costs – especially the cost of the environment. It's time we look to truly mitigating our effects on the environment in all development, not just the obvious ones.

To this end, STR-STH feels it is time for the State of CT to fully empower the Environmental Protection half of DEEP with the resources and human capital they need to not just review and comment on developer's plans, but also monitor and enforce regulations to protect CT's remaining lands, natural resources and especially water quality.

In terms of water quality, that means the use of Low Impact Development principles – not just pushing runoff from the new development to the nearest stream or river untreated and in much larger quantities. Our CT trout streams are irreplaceable and dependent on clean water in the quantities that created the streams. Our CT estuaries are fragile and most of them are already, as in the case of the Niantic River Estuary, impaired for recreational use or fishing/shellfishing. We need to do more in regard to stormwater retention and mitigation from development projects. Not just during construction, but post-construction. STR-STH feels it is time for the State of CT to have stormwater regulations that REQUIRE developers to not only mitigate the increased runoff from their projects, but also REQUIRE that runoff to be clean and of low or no impact to surrounding lands and waterways.

Specifically, in regard to solar regulations, STR-STH whole heartedly endorses Professional Engineer Steve Trinkaus's recommendations for Low Impact Development for stormwater plans for ground mounted solar installation (**see Attachment 1**). STR-STH feels that Mr. Trinkaus, PE, is uniquely qualified to give DEEP an informed and insightful review of their new ground mounted solar regulations and be able to give targeted and impactful suggestions as he:

1) has a deep knowledge of forestry (BS in Forestry Management), so he understands how the environment works in its natural state,
2) is a Professional Engineer with expertise in Low Impact Development that he is internationally known for,
3) he has studied the failures at the East Lyme Antares Solar Project onsite as he was retained by a downstream landowner in a lawsuit over damages from stormwater runoff against the solar company (**see Attachments 2 and 3** for his review and comments on how to address the post-construction runoff issues)
4) he has reviewed and officially commented to the CT Siting Council on both the plans for the initial (2018) and for the current (2020) solar project proposals for Waterford,
5) he has reviewed and officially commented to the CT Siting Council on the plans for the solar project proposal for the Cobb Road, LLC solar project in Old Lyme, and
6) he is currently the planning PE for the development of a ground mounted solar project where he is developing the stormwater mitigation plans as part of the engineering for the overall project.

STR-STH asks that strong weight be given to Mr. Trinkaus's comments because if they are used and brought into the regulations, ground mounted solar stormwater disasters like the many that were in the DEEP presentation on January 8 at the public announcement of the new regulations will be prevented. If they are left the way they stand today, STR-STH fears many more trout streams, wetlands and estuaries will be destroyed as CT pushes towards its carbon-free power goal for 2040. The Environmental Protection side of DEEP has the opportunity to learn from the past mistakes of sites like the ones in Pomfret and East Lyme and develop regulations that will prevent ground mounted solar stormwater disasters from happening again. STR-STH is asking that you do just that by incorporating Mr. Trinkaus's ideas and suggestions into the new DEEP regulations.

Thank you again for this opportunity and for your consideration of our comments.

Sincerely,

D. Moshier-Dunn

Deb Moshier-Dunn, VP
Save the River-Save the Hills, Inc.

Attachment 1

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February 5, 2020

Mr. Chris Stone, PE
CT DEEP
79 Elm Street
Hartford, Connecticut 06106-5127

Re: Proposed Stormwater Requirements for Ground Mounted Solar Arrays:

Dear Chris,

I have reviewed the proposed modifications to the document entitled "Appendix I Stormwater Management at Solar Array Construction Projects" as prepared by your department. Before I provide my comments, I want to provide a commentary on the stormwater and erosion issues which I have seen on several small and large ground mounted solar arrays.

A. Many ground mounted solar arrays are located on farmland or forest areas. When located on densely vegetated farm fields, such as for hay or undisturbed forest land, many environmental benefits are lost as follows:
    a. Deciduous, evergreen trees as well as all other herbaceous and woody vegetation provide interception of rainfall via branches and leaves, thus reducing the amount of rainfall which directly hits the ground surface. Some of the intercepted rainfall is absorbed by the leaves for use in photosynthesis. Other intercepted rainfall runs the branches and trunk to the ground surface where is will infiltrate into the forest litter layer found on the ground surface. This environmental benefit will be fully LOST when densely vegetation areas are used for ground mounted solar arrays.
    b. By the interception of rainfall by the branches and leaves, the velocity of the falling raindrops is greatly reduced and thus when the raindrops reach the ground, they do not cause erosion of the forest litter layer. This environmental benefit will also be fully LOST by ground mounted solar arrays.
    c. All growing vegetation (trees, shrubs and herbaceous groundcover species) found in the forest and other vegetated areas absorb carbon dioxide from the air and release oxygen. Carbon from the carbon dioxide is stored in all woody vegetation and sequestered from being released.
B. Many of the sites which I have reviewed proposed some degree of grading of the area of the ground mounted array. Even when the extent of grading is minor (2' cut or fill from existing grade), the natural properties of the soil are adversely

affected. In other cases, the grading has been substantial (greater than 2' cut or fill from existing grade). In both cases, all stumps and woody debris is removed from the ground surface. The natural topsoil layer is removed, and underlying soils are disturbed. The movement of construction equipment over the soil surface compacts it, thus reducing the natural porosity (infiltrative capacity) of the soil. The result in all cases is a significant reduction of infiltration and a significant increase in the amount of runoff from rainfall events,

C. Compacted soils make the establishment of new vegetation very difficult as the roots simply are unable to penetrate the ground surface. When vegetation can grow, it is not a contiguous fashion, but has many bare soil areas.
D. In the plans which I have reviewed and the site I inspected in the field, runoff from the soil panels is not falling on the ground surface and running perpendicular to the panel rows. Runoff is falling off the panels and then running parallel to the panel rows. As this runoff moves down the slope, it becomes more concentrated. Concentrated flow has a higher velocity and thus a higher ability to erode the ground surface, which occurred at the array in East Lyme.
E. Many of the sites have some type of stormwater practice located at the bottom of the array rows and it is assumed that the runoff from the array always occurs as overland flow and not concentrated flow. This simplistic assumption has resulted in the failure of stormwater basins and erosion control systems on East Lyme and Pomfret solar arrays.
F. Whether grading is proposed or not, in the plans which I have reviewed, the solar panels have not been considered impervious. The assumption by the designer results in both the peak rate and runoff volume being under-estimated by roughly 40% or more depending upon the site.
G. Designers make a further error in judgement by using the same soil classification for post-development conditions as for pre-development conditions which assumes that there are no changes to the ability of the soil to infiltrate runoff. As stated above, post-development soil conditions will generate more runoff as less infiltration occurs. This assumption contributes to under-estimating post-development peak rates and runoff volumes.
H. The designers make another incorrect assumption in using post-development vegetative cover as being in Good Condition, the best condition used in TR-20 or TR-55 Hydrologic Models. It takes years for any vegetative cover to become fully established, so this assumption again contributes to the under-estimation of runoff for post-development conditions.
I. Contractors are disturbing more than five acres at one time and the erosion control measures in the field are inadequate to control stormwater from the disturbed soils.
J. Erosion control plans rely on a single row of siltation fence barrier or other type of erosion control barrier at the bottom of the slope. A singular row of a barrier is easily overwhelmed by the concentrated flow which has occurred in the field.
K. No provisions are made to restore the infiltrative capacity of compacted soils prior to vegetation.
L. Designers are under-estimating the affect of long slopes and steep grades of disturbed areas and how long flow paths are responsible for the high velocity, concentrated runoff during the active construction period.
M. In some cases, topsoil has been removed from the site in the beginning of the construction period and then not returned to the site. In addition to soil

compaction issues, the lack of an organic topsoil adversely affects the establishment of vegetation on the soils.

It is my professional opinion that the requirements found under (1)(a) to (e) of the draft standards will not address the stormwater issues associated with the Ground Mounted Solar Arrays. I would propose that the following requirements take the place of this section.

Proposed Stormwater Standards for Ground Mounted Solar Arrays:

1. Paved access driveways, Gravel access driveways, concrete or bituminous concrete pads for electrical equipment, and solar panels shall be considered 100% impervious for the purposes of calculating the required Water Quality Volume (WQV) per Section 7.4.1 of the CT DEP 2004 Storm Water Quality Manual "2004 Manual"; the Groundwater Recharge Volume (GRV) per Section 7.5 of the 2004 Manual as well as all stormwater management computations.
    a. Soil types shall be obtained from the Natural Resource Conservation Service Websoil Survey (https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx) and verified by the excavation of a sufficient number of test holes within the area of the soil array and any stormwater practice in the field.
    b. The soil class for determining the Runoff Coefficient Number (RCN) shall be increased by one soil class if there is any disturbance of the ground surface ***(Rationale: the movement of construction equipment will compact the soil surface)*** or regrading within the solar array which is 2' higher or lower from the original ground surface ***(Rationale: regrading of native soils reduce the porosity of the native soils, thus reducing the infiltrative capacity of the soil)***. A Class B soil for pre-development conditions would become a Class C soil for post-development conditions.
    c. The soil class for determining the RCN shall be increased by two soil classes if the regrading within the solar array is greater than 2' higher or lower from the original ground surface. These requirements are fully applicable whether the regrading is a cut or a fill. A Class B soil for pre-development conditions would become a Class D soil for post-development conditions.
    d. All disturbed areas within the area of the solar array and the areas cleared or disturbed to provide full solar exposure shall be vegetated with an appropriate seed mixture containing native plants.
    e. Vegetated surface under and between the rows of solar panels shall be modeled either as Meadow in Fair Condition or Lawn in Fair Condition (50% to 75% coverage) on the modified soil class for post-development conditions. ***(Rationale: It takes a minimum of two to three years for vegetated surfaces to be fully established, so using Fair Condition is a more accurate representation of the ground surface in determining the post-development runoff conditions. Meadow in particular requires years to fully develop with roots systems extending 12" or more down into the soil, which provides pathways for rainfall to infiltrate).***
    f. All Stormwater management basins shall be designed in full compliance with the standards defined in the 2004 Manual for a practice.

g. Stormwater practices shall be proposed as specified in the 2004 Manual as off-line or on-line with appropriate pre-treatment of runoff as well as bypass provisions. ***(Rationale: I have seen Infiltration basins proposed for solar arrays which will receive runoff from all rainfall events. This approach has failed in practice. Practices to address water quality are required to off-line to treat Water Quality Volume or Water Quality Flow only with an appropriate by-pass system for events larger than the water quality storm (1" of rain/24 hours).***

h. The Stream Channel Protection requirement per Section 7.6.1 of the 2004 Manual shall be met for all stormwater basins at all discharge points for the solar array. The Stream Channel Protection requires that the post-development peak rate for the 2-year/24-hour rainfall event (using NOAA 14 data) shall be reduced to 50% of the pre-development peak rate for the 2-year/24-hour rainfall event.

i. Peak Rate attenuation shall be provided for the WQ storm (1" of rainfall per 24 hours), the 1-year, 2-year as noted above, and 10-year, 24-hour rainfall events using NOAA 14 data.

j. Overflow provisions for passing the 25 year/24-hour rainfall event, 50-year/24-hour rainfall event and the 100-year/24-hour rainfall event using NOAA 14 data shall be incorporated into the design of all stormwater basins.

k. Conveyance systems such as Dry Swales, Wet Swales or Riprap Swales shall be used to convey runoff from the perimeter of the solar array to an appropriately designed stormwater basin. All swales shall be designed in full compliance with the specifications found in the 2004 Manual. Flow velocities within the swales shall be non-erosive for the surface material (grass, stone, etc.). Field stone check dams shall be used to maintain non-erosive flow velocities.

l. Flow velocities for all stormwater discharges from stormwater basins shall be reduced by appropriate outlet protection sized in accord with the CT DEP Guidelines for Soil Erosion and Sediment Control "2002 Guidelines" and shall be reduced to non-erosive velocities for the 25-year rainfall event using NOAA 14 data.

m. Discharges from all stormwater basins shall be to either a) a well-defined stable wetland boundary or watercourse (intermittent or perennial) or b) an upland area where it must be shown that the discharge will remain as overland flow and not become concentrated flow. Measures defined in the 2004 Manual shall be used to convert concentrated flow to overland flow. If flows are not directed to a defined wetland or watercourse, non-erosive velocities must be provided when the runoff leaves the site under control of the applicant.

Comments on other sections of ***Design and construction requirements:***

(2): The vertical clearances of the panels to the ground surface are based upon the angle of the panels and the specifications of the manufacturers. This standard is too prescriptive (one size fits all) to work in the real world.

(3): A third party review of the erosion control/phasing plan and stormwater management plan shall be done by a licensed professional engineer with proven significant expertise in these fields. In my experience, the Conservation Districts do not have the expertise to evaluate the design of the stormwater management systems for these projects.
(4): The Licensed Professional Engineer shall perform the required inspections of the site during the active construction period as required by the CT DEP 2002 Guidelines for Soil Erosion and Sediment Control "Guidelines".
(5): This requirement is acceptable.
(6): A minimum of five (5) day notice shall be provided by the Licensed Professional Engineer for the project to the CT DEEP prior to commencement of any construction activity on the site, including the cutting of trees.
(7): This requirement is acceptable.
(8): A bond is a good idea. However, the $15,000/acre is excessive. The purpose of a bond of this type is to ensure that the approved design is constructed per the design in the field. The issue which has been observed in the field on several sites is that the design of the erosion control plan and stormwater management designs have not been adequate for the site. If the plan is inadequate, then no amount of bond will be enough to fix the problems. A bond of $ 2,000/acre is more than adequate for the correction of any erosion issue during the construction period when an appropriate erosion control plan has been designed and approved.

Design requirements for post-construction stormwater management measures:

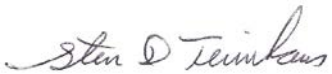
The listed requirements in (1), (2), (3) (a to e inclusive) can be eliminated as they are addressed above. The following provisions shall take their place.

1. Solar arrays shall not be permitted on slopes greater than 15% as measured along the alignment of the row of solar panels.
2. A Storm Water Pollution Prevention Plan (SWPPP) shall be prepared by the applicant which fully complies with the 2002 Guidelines.
3. The SWPPP shall be reviewed by a Qualified Licensed Professional Engineer (per the General Permit) and a written statement of acceptance shall be provided by the Qualified Licensed Professional Engineer.
4. Appropriate and adequate erosion control measures shall be implemented on the site to reduce the slope length of disturbed areas to prevent the concentrated flow down a long earth slope.
5. The area to be disturbed (stump removal and/or grading) for the solar array shall be limited to five (5) acres at one time. The area must be stabilized with vegetation (75% vegetative cover over the area) prior to moving to the next phase.
6. If the area to be disturbed at one time is more than five (5) acres, the requirements of Part 1: Large Construction Site Sequences found on pages 4-2 to 4-5 of the CT DEP Guidelines for Soil Erosion and Sediment Control shall be fully complied with.
7. Permanent stormwater basins shall be constructed in the early phases of the project, vegetated with appropriate seed mixture or plugs so that they are ready to accept stormwater when the array is constructed.

8. Permanent stormwater basins shall NOT be used as temporary sediment basins or traps during the active construction period as they cannot be stabilized appropriately to accept post-development runoff.
9. Short term and long-term Maintenance specifications and plans shall be provided for all components of the stormwater management system for the solar array.

Please feel free to contact me if you have any questions concerning this information. I believe a public hearing is necessary so that all opinions on the proposed regulations can be presented for discussion.

Respectfully Submitted,
Trinkaus Engineering, LLC



Steven D. Trinkaus, PE

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November 6, 2018

Ms. Leslie King, Esq.
Murtha Cullina
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New Haven, Connecticut 06510

Re: Solar Farm – Grassy Hill Road
East Lyme, Connecticut

Dear Ms. King,

Statement of Purpose:

You asked me to opine on the adequacy of the design and construction of the stormwater management system and erosion control elements of the solar farm on Grassy Hill Road in East Lyme, Connecticut. You also asked me to opine on whether those elements contributed to damage on the neighboring property of John Bialowans.

To reach my opinion associated with the solar farm constructed on Grassy Hill Road in East Lyme, I have reviewed the following:

1. Site inspection on October 5, 2018 of the completed solar farm on Grassy Hill Road and the streams on the Bialowans property.
2. Site plans prepared for Antares Solar Field by BL Companies, dated: October 9, 2012 and revised to July 16, 2013 as on file at the Connecticut Siting Council.
3. Stormwater Management Report prepared for Antares Solar Field by BL Companies, ("BL") dated: October 9, 2012 as on file at the Connecticut Siting Council.
4. Show Cause Hearing before East Lyme Wetlands Agency on May 5, 2014 on Cease and Desist Order Entered 6/10/2014 Report by Environmental Planning Services of April 30, 2014 regarding breach of erosion control/stormwater management measures.
5. Findings of Fact for Petition #1056 – GRE 314 East Lyme, CT by the Connecticut Siting Council, dated: May 16, 2013.
6. Four photographs of breach of erosion control/stormwater management measures (not dated) taken by others.
7. Photographs taken on 10/5/18 of the area of the solar farm, and stormwater management system as well as the streams on the John Bialowans property by my office.

Executive Summary of Opinions:

1. In the stormwater management report, BL grossly underestimated both the peak rate and runoff volumes generated by the project as they mistakenly consider the solar panels to be pervious. The panels are situated above the ground surface, thus every raindrop which falls on a panel instantly becomes runoff. They are impervious.
2. The developer and BL's design did not account for changes in soil compaction and porosity which resulted from the considerable regrading of the solar farm. The substantial cuts and fills of the solar farm resulted in a soil surface that has no infiltrative capacity, which will generate significantly more runoff than the undisturbed pre-development conditions.
3. The detention basin and leaky berm designed by BL are inadequately designed to attenuate the increases in runoff volume and peak rates of runoff. Because the design of the stormwater management practices inadequately addressed the actual amounts of runoff generated by the solar farm, the detention basins have not functioned as designed.
4. It is my professional opinion that BL's design of the erosion control plan was negligent, and certainly inadequate for its intended purpose. That design resulted in the failure of the erosion control measures during the construction period, resulting in the discharge of substantial amounts of sediments to the downgradient wetland and watercourses. The sediments smothered portions of the existing wetland system, resulting in a loss of natural functions of the wetlands.
5. It is my professional opinion that the design of the stormwater management system was negligent and inadequate and resulted in the discharge of higher volumes of runoff to the downgradient streams, resulting in the erosion of the channel banks and deposition of the eroded material.
6. The Solar farm was not designed in compliance with the specifications and approaches found in the State of Minnesota Stormwater Manual for solar farms as adopted by the CT DEEP. This is very important as the Minnesota Stormwater Manual sets forth very specific requirements for solar farms where the solar panels (which are solid impervious panels) can be considered pervious for the design of a stormwater management practice. These specifications and approaches in the Minnesota Stormwater Manual were not followed for the solar farm on Grassy Hill Road in East Lyme.
7. BLdid not design stormwater management and erosion control systems within the appropriate standard of care.
8. These inadequately designed and constructed stormwater management and erosion control systems caused substantial damage to the streams on the adjacent property owned by John Bialowans.

To support the above opinions, I have the following comments:

Developers Stormwater Management Plan and Report:

1. The developer did not consider the solar panels to be impervious. This was a substantial error in the developer's stormwater management analysis. While the solar panels are not actually on the ground surface, they do block the rainfall from reaching ground, thus each

drop of rainfall effectively becomes a drop of runoff. This runoff then falls onto the regraded, compacted soil surface and flows downhill. There was and will continue to be virtually no infiltration of runoff on this solar farm.

2. When soils are cut, filled, or have the surface regraded as was proposed here, the soil classification for use in the Hydrologic Model will change by at least one group designation. In this case, the Class C soils (pre-development) would become Class D soils and for a given ground cover would have a higher Runoff Curve Number (RCN). Therefore, both the peak rate and runoff volumes were and continued to be higher prior to the construction of the solar farm.
3. This error of using the wrong RCN has resulted in greatly underestimating the post development peak runoff rates and volumes for all storm events. Because the rates and runoff volumes are significantly higher than those calculated by the applicant, the design of the stormwater basins is also incorrect and are undersized.
4. The developer did not account for the Class D soils within the wetland area within drainage area A. Class D Soils will generate more runoff than a Class C Soil.
5. The time of concentration (Tc) flow path for both area A and B is not perpendicular to the contours in multiple locations. This Tc shortened when the peak rate of runoff occurs.
6. The shallow concentrated portion of the Tc for Drainage Area A is using what appears to be an average slope and does not account for steeper portions of the flow path which would result in a faster Tc and thus a higher peak rate of runoff.
7. The shallow concentrated flow portion of the Tc for Drainage Area B is using what appears to be an average slope and does not account for the steeper portions of the flow path which would result in a faster Tc and thus a higher peak rate of runoff.
8. In Drainage Area B, the developer stated that the Shallow Concentrated Flow path extends for over 1,600 feet along the edge of Walnut Hill Road, yet it does not appear that Walnut Hill Road is a through road based upon the watershed map and the flow path is not perpendicular to contours. As noted above, these assumptions made by the developer affected when and how much the peak rate of runoff is.
9. There was no investigation of on-site soil conditions to verify NRCS soil mapping.
10. Drainage Area A-1, A-2, A-3, A-4 and A-5 under post-development conditions are significantly regraded. Cuts up to 6' were made and fills up to 6' were made and yet the applicant claims in the stormwater report that the pre-development soil conditions will be applicable to post-development conditions. This is completely incorrect. When soils are cut and filled as was proposed here, the natural soil properties, particularly the ability of the regraded soil to infiltrate runoff and allow vegetation to become established are eliminated or significantly reduced. The regrading of the natural soils on the solar farm when combined with soil compaction, provided a soil base on which to install the solar panels which resulted in no infiltration of rainfall and increased rates and volumes of runoff being discharged from the solar farm for all rainfall events.
11. Drainage Area B-1 under post-development conditions is significantly regraded. Fills up to 10' were made and yet the applicant claims in the stormwater report that the pre-development soil conditions will be applicable to post-development conditions. This is completely incorrect. When soils are cut and filled as was done here, the natural soil properties, particularly the ability of the regraded soil to infiltrate runoff and allow vegetation to become established are eliminated or significantly reduced. The regrading

of the natural soils on the solar farm when combined with soil compaction, which provided a soil base to install the solar panels, resulted in surface condition with no capacity for the infiltration of rainfall and increased rates and volumes of runoff being discharged from the solar farm during all rainfall events.

12. The regraded slopes are uniform in pitch and have eliminated the natural depressions of the undisturbed slopes which would have allowed some of amount of rainfall to be trapped in the depressions and then infiltrated into the soils.
13. The long, uniform slopes also resulted in increased slope length of the soil surface. A key methodology for controlling runoff is to minimize the slope length under post-development conditions which prevents the runoff from becoming concentrated flow. Rainfall falling on these uniform services did not infiltrate, and instead it runs down the slope. As the rainfall runs down the slope, it becomes more concentrated in terms of runoff rate and volume, thus flow velocities increase. As the volume of runoff and flow velocities has increased, the erosive capacity of the runoff has also significantly increased sheet, rill and gully erosion on the slope. Once rill and gully erosion has occurred the initial time, the condition will worsen with each rainfall event. The condition on this site is continuing to worsen.
14. The CT DEEP has adopted standards and approaches developed by the State of Minnesota which are applicable to the development solar farms. The standards and approaches are found in the following link to the Minnesota Stormwater Manual:(https://stormwater.pca.state.mn.us/index.php?title=Stormwater_management_for_solar_projects_and_determining_compliance_with_the_NPDES_construction_stormwater_permit).
    a. The Minnesota Manual states the following *"Rain falls on a solar panel, which is impervious. The rain runs across the panel to the dripline, where it falls to the underlying surface. This water can infiltrate or run off downslope to the next panel. Considering the schematic to the right, runoff water passing across a length of (Y+Z) can infiltrate. Y is the downslope length from the dripline to the beginning of the next panel. The surface under Y is pervious with well maintained vegetation and receives direct rainfall in addition to runoff from the upslope panel. Water that runs across the land surface from one dripline to to the next dripline that does not infiltrate is considered to be the runoff."* However, there are several caveats to the above statement and these caveats are found in a subsection entitled "Assumptions and guidance" in the Minnesota Manual and are discussed in point below.
    b. The applicant misapplied the document entitled "Stormwater management for solar projects and determining compliance with the NPDES construction stormwater permit" which is part of the State of Minnesota Stormwater Manual.
    c. The Minnesota stormwater manual states that large scale solar farms can be considered "pervious" under certain conditions. These conditions are as follows:
        - The rows of solar panels must be set a minimum distance apart which in this case is 14.5'.
        - Runoff from the drip edge of one row of panels must fall on the ground and drain in a perpendicular direction toward the next downgradient row of panels.

- Projects must minimize site disturbance and grading activities where natural vegetation cover is preserved and/or restored.
- A "meadow" condition is preferable, particularly for slopes between 5 and 10 percent.
- Mowed areas, where approvable, should be kept to 4" minimum height.

These conditions were not met for the solar farm proposed in East Lyme. Specifically, a review of the grading plan showing the proposed solar panels show that runoff will flow parallel to the row of panels within the vegetated strip and not perpendicular for virtually the entire project area of 30 acres. The condition specified in the Minnesota Stormwater Manual that solar panels are pervious, which assumes a runoff flow perpendicular to the row of panels, is not applicable in this case. The soil surface was disturbed by the removal of stumps and organic debris and/or other regrading. Therefore, the condition specified in the Minnesota Stormwater Manual that "projects must minimize earth disturbance and grading activities…" is also therefore not applicable in this case. Lastly, many of the panels are located on slopes greater than 5.0% and the vegetation under and between the panels is to be lawn and not "meadow", so item 'e' above is not met.

d. Based solely on condition specified in the Minnesota Stormwater Manual the claim of the entire solar farm being pervious is erroneous. There is clear evidence in the field that concentrated runoff is flowing along the length of the vegetative strip and not perpendicular.
e. The entire 30 acre slated for the solar farm was clear cut, stumped and graded in several areas by substantial amounts, so the application is not minimizing site disturbance and grading activities.
f. Additionally, "meadow" is a natural condition, where it is only mowed for hay once a year and not lawn which is the ground cover in East Lyme.

Erosion and Sediment Control Plan:

1. The regraded slope on the west side of A-3 is over 15' in height and does not have reverse benches as required by the CT DEP 2002 Guidelines for soil erosion and sediment control.
2. The regraded slope on the west side of B-1 is over 15' in height and does not have reverse benches as required by the CT DEP 2002 Guidelines for soil erosion and sediment control.
3. Page GN-1 – grading and utility notes: Note #5 states that soils to be compacted in 8" maximum lifts under all building areas to 95% maximum dry density by ASTM D1557 (modified proctor test) or as directed by geotechnical engineer. By compacting the soils to this degree will make them structurally sound to build on, but also eliminates the ability of the soil to infiltrate any amount of rainfall, thus substantially increasing the amount of rainfall which becomes runoff even from a grass surface.
4. Based upon a literature review, the "leaky berm" proposed by the applicant does not conform to industry practice. The applicant proposes that the "leaky berm" will have a layer of crushed stone underneath of covering of topsoil with a layer of filter fabric separating the two materials. The idea is that runoff from an upgradient area will enter

the swale just above the "leaky berm" and slowly seep through the berm. Based upon the literature review, a "leaky berm" should commonly consists of several layers of gravel on top of each other with the finer gravel being on the bottom and larger gravel above to allow the flow rate to be higher. This system is commonly used to maintain a water surface in a pond or wetland and they allow overflows to occur in a dispersed fashion over a wide area. In this case, if the gravel layer of the "leaky berm" was clogged by sediment, flows within the upgradient swale would be directed to one or more of 4" PVC pipe installed through the berm. This would result in concentrated runoff being discharged instead of overland flow. In my professional opinion, the "leaky berm" by the applicant is not a proper runoff control method for this solar farm as the runoff directed to it is substantially higher than anticipated by the applicant. It was also not designed in accordance with industry standards for this type of stormwater practice.

5. The applicant proposed to cover certain steep slopes with North American Green product P300 permanent turf reinforcement mat. The detail on the plans show the mat to be installed perpendicular to the slope. Based upon pictures of the failure of the erosion/stormwater control measures, the actual fabric was installed parallel to the slope. This is simply wrong as installation parallel to the slope allows runoff to get under the mat surface and cause erosion of the underlying soils. It does allow not appear in the photographs that mat was properly stapled to the ground surface. (See Figure 1).
6. In several locations on the proposed plans, the perimeter control measures, silt soxx was installed perpendicular to contours which would cause concentrated flow to occur along the silt soxx and potentially overtop a down gradient erosion control installed parallel to the contours.
7. On Sheet EC-5 of the plan set, the silt soxx starts and stops on either side of outlet from a stormwater basin and/or spillway, so there is no erosion control measure directly downstream of outlet pipes for all detention basins or other outlets. This would any erosion of the berm uphill of the outlet pipes to be directly discharged to downgradient wetlands and watercourses.
8. Based upon photographs of the failure of the erosion/stormwater management controls, the soil in the berm was not compacted per the requirements on the plan and thus was highly susceptible to saturation and failure. If the soil in the berm was properly placed and compacted, it is unlikely that the berm would have failed as shown in Figure 2 and Figure 3.

Figure 1 - Erosion Control Blanket (mat)

Figure 2 - Failure of Stormwater Basin Berm

Figure 3 - Failure of Stormwater Basin Berm

Site inspection of Solar Farm and the streams Bialowans Property on 10/5/18:

1. The area under and between the soil panel arrays are maintained as mowed grass. This condition will generate more runoff than a "meadow" condition as specified in the Minnesota Stormwater Manual. (Figure 4).
2. The grassed areas between the rows of solar panels all pitch parallel to the panel rows which allows runoff to become concentrated flow. (Figure 4).
3. The operator of the solar farm must have experienced this concentrated flow as there are stone berms located at the downhill end of each grass row prior to the stormwater basins which were not on the approved plans. The only purpose for these stone berms is to slow the velocity of the runoff down. (Figure 5).
4. There is clearly no infiltration occurring within the grass areas between the solar panel rows as concentrated flow and rill erosion was observed. (Figure 6, Figure 7).
5. Erosion of the slope on the uphill side of at least two stormwater basins was observed, this is further evidence of concentrated runoff being generated by the solar farm. (Figure 8).
6. All the stormwater basins have been lined with modified riprap which was not specified on the approved plans.
7. Facultative wetland plants have become established in the bottom of most, if not all the stormwater basins which are clear evidence that no infiltration is occurring in these basins as represented in the stormwater management report for this project. (Figure 9).

Figure 4 - Grass under and between solar panels

Figure 5 - Stone Berms at downhill end of panel rows

Figure 6 - Concentrated flow from runoff off solar panel

Figure 7 - Erosion & Sedimentation resulting from concentrated flow

Figure 8 - Erosion of stormwater basin slope from concentrated runoff

Figure 9 - Wetland Conditions in Bottom of Stormwater Basin

Findings of Fact by the Connecticut Siting Council of May 16, 2013:

Condition #68 of the Findings of Fact states "No wetlands or watercourses would be directly affected by construction of the solar field." This condition was violated by the developer in the following manner. During the active construction period a significant discharge of sediment was discharged from the solar farm (Environmental Planning Services report of

April 30, 2014) and into the downgradient wetlands and watercourses resulting the deposition of sediment in wetlands and watercourses. The discharge of sediment was the direct result of the inadequacy of the erosion and sediment control plans prepared for this project.

The un-named stream on the Bialowans property is experiencing erosion of the channel banks after the development and stabilization of the solar farm due to the discharge of increased runoff volumes from the solar farm. The increased runoff volumes being discharged are a direct result of the invalid assumptions made in the stormwater management report and plan.

Condition #89 of the Findings of Fact states "No increase of run-off is anticipated from the solar panels. A crushed stone drip line would be installed beneath the edge of each solar panel to facilitate water percolation into the soil. Well-drained soils are within the soil field, further enhancing percolation." This condition has been violated in the field by the developer as the stone drip line was not installed in the field. Additionally, because of the assumptions made in the stormwater management report, significant increases of runoff volume are being discharged from the solar farm and adversely affecting the un-named watercourse on the Bialowans property.

Stream Impacts on Bialowans' Property:

I have also inspected the unnamed stream and Cranberry Meadow Brook on the Bialowans' property. There is clear evidence that increased runoff volumes from the solar farm is adversely affecting the channel of the unnamed stream. Figure 10 shows one spot of several in the unnamed brook where the channel bank is being undercut by increased runoff volumes and flow duration from the stormwater basins on the solar farm property. In other words, the stream channel is physically reacting to the increased volume and flow duration of runoff from the solar farm, with the erosion widening the channel width to accommodate the higher flows. Figure 11 shows additional channel bank undercutting in the unnamed stream. Figure 12 shows the deposition of eroded material from the un-named stream at the confluence with Cranbury Brook. Lastly, Figure 13 shows the adverse impact of increased runoff volumes and flow duration from the stormwater basins on the solar farm property. Figure 13 shows erosion of the channel banks at the rear of the photograph as a result of the increased flow duration of the runoff from the solar farm. Additionally, the increased runoff volumes have higher flow velocities and this has resulted in the flow being able to move large branches down the channel and then deposit them in the channel when the flow velocities slow down. Lastly, the large sediment deposit in the foreground of the photograph is the material which has been eroded from the channel banks by the increased runoff volumes and flow duration.

Figure 10 - Undercutting of channel bank of un-named stream on Bialowans Property

Figure 11 - Erosion and sedimentation in un-named stream on Bialowans Property

Figure 12 - Eroded material deposited adjacent to Cranberry Meadow Brook on Bialowans Property

Figure 13 - Eroded material and debris from un-named stream near confluence with Cranberry Meadow Brook on Bialowans Property

My CV is attached to this report. Please feel free to contact my office if you have any questions concerning the information found in this report.

Respectfully Submitted,

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Qualifications	B.S. / Forest Management/1980 University of New Hampshire
Licenses/Certifications	Licensed Professional Engineer- Connecticut (1988) Licensed Professional Engineer – Maryland (2017)
Professional Societies	American Society of Civil Engineers National Society of Professional Engineers Connecticut Society of Professional Engineers Soil and Water Conservation Society of America International Erosion Control Association American Society of Agricultural and Biological Engineers
Professional Awards	Steve was named an Industry Icon by Storm Water Solutions in July 2015 http://editiondigital.net/publication/?i=263831&p=16 for his work in the Low Impact Development field.

International Experience

South Korea – July 2017, June 2016, April 2015, October 2014, April 2014, October 2013 and June 2013

- Steve was invited by Dr. Leeyoung Kim of Kongju University to make a presentation at the Seoul International Symposium for water cycle held on July 27, 2017 at Seoul City Hall. Steve's presentation was entitled "Sustainable Urban Water Cycle Management, Low Impact Development Strategies for Urban Retrofits". Steve also made a presentation to Master and PhD Engineering students at Kongju University on designing LID treatment systems. He also visited the research office of Land & Housing Institute in Daejeon to inspect recent LID retrofits consisting of Bioretention systems, Bioswales and Permeable Paver systems.
- Steve was invited by Dr. Shin to visit the Korean GI/LID research center in July of 2017. The purpose of the visit was to inspect the LID research systems which had been in place for a year to observe how well they were functioning and also to observe the current research on infiltration of LID systems and evaportranspiration of green roof systems.
- Steve was an invited attendee to the official opening of the Korean GI & LID Research Center recently constructed at the Yangsam Campus of Pusan National University. Steve was a consultant on the design of the research center for Dr. Hyunsuk Shin of Pusan National University.

- Steve was an invited presenter at the World Water Forum by Dr. Hyunsuk Shin of Pusan National University. He presented case studies of GI/LID applications in the United States.
- Steve was invited by Dr. Yong Deok Cho of Kwater to participate in the Water Business Forum at the World Water Forum. Steve presented an overview of his business and expertise in Low Impact Development.
- Steve was invited by Dr. Hong-Ro Lee of Kunsan National University and made a presentation entitled "Understanding Low Impact Development in the Urban-Rural Interface" for the **Ariul Brainstorming Working Group** on April 16, 2015 in Gunsan, South Korea. He also toured portions of the proposed land reclamation area to assess how Low Impact Development strategies could be incorporated to address water quality issues from the proposed agricultural, residential, commercial and industrial land uses for this area.
- Steve was a Contributing Author as well as an Advisory Reviewer for a report prepared by Land & Housing Institute (LHI) entitled " Pyeongtaek Godeok New City Low Impact Development techniques (LID), A study on the introduction of measures (I) " dated: January 2015. This report by LHI also cited the Town of Tolland LID Design Manual as a foreign LID Manual to be used as a reference document.
- Steve was an invited presenter at the International Water Forum 2014 held in conjunction with the Nakong River International Water Week in Gyeongju, South Korea sponsored by DaeGyeong Water Foundation & the International Hydrologic Environmental Society. His presentation focused on urban stormwater and the benefits of LID in these areas.
- Steve was an invited presenter at the IWA Water Reuse & Energy Conference 2014 held in Daegu, South Korea. His presentation was on the regulatory barriers to implementation of LID and how to overcome these barriers. He also participated in a panel discussion with other presenters.
- He also made a presentation at The 1st GI & LID Technical Education Workshop held at Pusan National University on October 22nd on an overview of LID and the application of LID concepts. He was invited by Dr. Kyung Hak Hyun of Land & Housing Institute (LHI) to make two presentations of LID case studies at Sangyung University and at a seminar hosted at LHI along with Kwater.
- Steve met with Jong-Pyo Park, Director and Kyoung-Do Lee, CEO of HECOREA, a water resource consulting firm to discuss LID in dense urban areas. Steve signed a MOU with HECOREA to provide consulting services on LID monitoring approaches and maintenance protocols for the Go-Deok International Planning District near Pyeongtaek, South Korea.
- Steve was invited by Dr. Kyung Hak Hyun of Land & Housing Institute to present at the 2nd Low Impact Development Forum in Daejeon, South Korea on October 31, 2013. He also inspected the site of Asan-tangjeong which is an expansion of residential housing for the city of Asan. This expansion will incorporate LID stormwater strategies.
- Steve was invited to make a presentation of the implementation of LID on commercial sites by Dr. Reeho Kim of the Korea Institute of Construction Technology in Seoul.
- Steve met with Dr. Sangjin Lee of Korean Water and Dr. Woo Young Heo, CEO of LID Solution Co, Ltd to review the initial concept plans for the Eco-Delta City project. Eco-Delta City is a new city located near the Gimhae International Airport of 13 square kilometers and will incorporate LID concepts throughout the new city.

- Steve signed a MOU with Dr. Shin of Pusan National University to provide consulting services for the Smart GI/LID Research Facility at Pusan National University. Steve was asked by Dr. Shin to review the design plans for the GI/LID research facility to be constructed at Pusan National University with a focus on the exterior LID research facilities. He provided a written comprehensive review for consideration by PNU.
- Steve was invited by Dr. Hyunsuk Shin of Pusan National University in South Korea to present a workshop on Low Impact Development on June 24, 2013. The presentation was made to research professors, graduate engineering students and practicing engineers at K-water headquarters in Daejeon, South Korea. He also met with representatives of other agencies tasked with the development of a new city, called Eco-Delta City which will implement LID practices from the ground up and comprises approximately 3,500 acres.

Nanjing, China, September 2018
Steve was invited by the organizing committee for the third China Sponge City International Exchange Conference to make three presentations on LID. The presentations were entitled: "LID: The Good, the Bad and the Ugly", "Permeable Pavement Case Studies" and "The regulatory framework to adopt LID". The conference was held September 27th and 28th in Nanjing, China.

Beijing/Zhenjiang, China – August 2017
Steve was invited to make a presentation entitled "Urban LID in China and South Korea" at the 2017 Second China Sponge City International Exchange Conference held in Beijing on August 16-1, 2017. He also made a presentation for Dr. Nian She, Director of Smart Sponge City Planning and Construction Research Institute in Zhenjiang, China on modeling approaches for LID treatment systems as well as inspecting some recent LID retrofits currently under construction in Zhenjiang.
Steve also made a presentation at Reschand entitled "LID Case Studies from US" at the request of Yuming Su of Reschand.

Nanjing, China – September 2016
Steve was invited to present at the 2016 First China Sponge City International Exchange Conference held in Nanjing, China. The presentation focused on several case studies of LID systems in the US.

Zhenjiang, China – June 2015
Was retained by Dr. Nian She to design Urban LID retrofits for a 2.5 hectare (6.5 acres) dense residential area in the city of Zhenjiang. The LID retrofits had to fully treat runoff from the existing impervious areas (building roofs, driveways and parking areas) for 65 mm (2.6") of rainfall in 24 hours. The LID systems also had to attenuate the peak rate of runoff for a rainfall event of 150 mm (5.9") rainfall event. A combination of Bioretention systems, and permeable pavers with a filter course and reservoir layer were used to meet these stormwater requirements.

Zhenjiang, China – May 2015
Steve was invited by Professor Nian She of Shenzhen University to make a presentation entitled "Using LID to Attenuate Large Rainfall Events and Reduce Flood Potential" at the 2015 First

Sino US Sponge City LID Technology Practice Conference held on May 4-5, 2015 in Zhenjiang, China organized by Zhenjiang Water Supply and Drainage Management Office. (http://www.c-water.com.cn/2015lid/en/index_e.html). In addition to the presentation, field inspections were made of several new LID installations in the city consisting of Bioswales, permeable pavement systems and rainwater harvesting.

Guangzhou, China – December 2012

- Steve was an invited attendee at the 15th Annual Guangzhou Convention of Chinese Scholars in Science and Technology in Guangzhou, China on December 17 – 21, 2012 to present a project narrative on how Low Impact Development and sustainable development can be applied to address water quality issues in urban and rural areas of China to implement sustainability concepts and conservation of resources. He attended with Dr. Jim Su, PE of Golder Associates of Mt. Laurel, New Jersey. While at the convention he met with representatives from Sichuan University, Chang'an University, Guangdong University of Technology, Shenzhen University and the South China Institute of Environmental Sciences, MEP to discuss LID being incorporated into their engineering programs.
- Steve also met Dr. Hongbin Cheng of New China Times Technology which is located in Stellenbosch, South Africa. Steve has signed a three-year partnership agreement with New China Times Technology to introduce LID concepts to the west cape area of South Africa.

Taiwan – December 2011

- Steve was invited by Hung Kwai Chen, Director of the Water Resources Planning Institute, Water Resource Agency, Ministry of Economic Affairs of Taiwan and Dr. Yong Lai of the US Bureau of Reclamation to present a 12-hour presentation on Low Impact Development on December 8th and 9th, 2011 in Taichung, Taiwan. The presentation focused on applying LID strategies in both urban and rural environments to address runoff volumes and water quality issues.
- Steve is an invited consultant to a project team headed up by Xiaoyan Zhou, PhD of the Institute for Taiwan Water Environment Research (TIIWE) along with The National Taiwan Ocean University, Hohai Engineering Professor Liao Chaoxuan, Ting Engineering Consultants Co., Ltd and University of Colorado professor Guo Chunyuan to develop a LID demonstration project in New Taipei City along with LID policy strategies to further the use of LID in New Taipei City, Taiwan.

Low Impact Development

- Review of existing municipal land use regulations to identify barriers to the implementation of Low Impact Development
- Preparation of regulatory language changes to facilitate the adoption of Low Impact Development
- Preparation of design manuals for the implementation of Low Impact Development strategies and processes with an approach that simplifies the design process

- Application of environmental site design strategies to focus development concepts on land most suitable for development while enhancing the protection of environmentally sensitive areas

- Design of Low Impact Development treatment systems, such as Bioretention areas, wet/dry swales, vegetated level spreaders, vegetated filter strips, subsurface gravel wetlands, constructed wetlands and/or pond systems, infiltration basins & trenches

- Hydrologic analyses of current and post-development conditions to assess impacts of proposed development on storm water flows

- Design of storm water control systems including detention and water quality basins and appropriate planting plans

- Perform hydrologic modeling of stormwater management systems to demonstrate compliance with regulatory benchmarks

- Prepare Pollutant loadings analyses to evaluate the effectiveness of stormwater treatment designs in reducing pollutant loads

Wastewater Management:

- Soil testing to determine suitability of land to support on-site sewage disposal systems for residential and commercial projects and assistance with identifying optimal location for both small and large scale system

- Perform necessary calculations to model and design large scale subsurface sewage disposal systems under CT DEEP criteria and State Department of Public Health

- Design of on-site sewage disposal systems in accordance with state and local health codes

- Perform construction oversight of both small and large scale subsurface sewage disposal systems and provide certifications of compliance

Site Engineering:

- Development feasibility studies

- Layout concepts to maximize development, while preserving environmentally sensitive areas

- Design of horizontal and vertical road geometry

- Preparation of grading, drainage and erosion and sedimentation control plans

- Use AutoCAD Land Development, Civil3D, HydroCAD and Pondpack software packages

- Layout and design of sanitary sewers

- Bid estimates

- Construction oversight
- Third party technical reviews
- Expert testimony

Professional Committees

- Chairman and primary author of EWRI/ASCE LID Model Ordinance Task Committee (goal is to create a National LID Guidance document to further the adoption of LID)
- Chairman of EWRI/ASCE LID Task Committee on Filter Strips and Bioswales (goal is to review & evaluate literature and design specifications for filter strips and Bioswales and create uniform design standards for different geographical regions)
- Member of EWRI/ASCE LID National Guidelines Task Committee
- Connecticut Representative to the Board of Directors of the Northeast Chapter of the International Erosion Control Association

Published Articles

- **"Easier Said Than Done – Overcoming common errors when installing bioretention systems"** – October 2018 edition of Storm Water Solutions by Scranton Gillette Communications.
- **"Large-scale LID Design for urban expansion in South Korea**" with co-author, Dr. Kyung Hak Hyun of South Korean Land and Housing Institute – Volume 3/Issue 4, August/September 2015 – Worldwater Stormwater Management by the Water Environmental Federation.
- "**Research team leads LID deployment in South Korea**" – Volume 2/Issue 1, Spring 2014 – Worldwater Stormwater Management by the Water Environmental Federation.
- "**Low Impact Development, Sustainable Stormwater Management**" – English article converted to Chinese and published in the Chinese Edition of Global Water Magazine, July 2013.
- "**A Case Study: Southbury Medical Facility and Low Impact Development**" - January/February 2014 issue of Land and Water.
- "**A True Pioneer of Low Impact Development – Member Spotlight**" – January/February 2014 Issue of Erosion Control – Official Journal of the International Erosion Control Association.
- "**Low Impact Development: Changing the Paradigm**" published in the March 2012 edition of PE, The Magazine for Professional Engineers by the National Society of Professional Engineers. Article was also republished in the Spring 2012 addition of EWRI Currents (with permission of NSPE).
- "**Stormwater Retrofit of Existing Detention Basins**" published in the March/April 2012 Land and Water, The Magazine of Natural Resource Management and Restoration with co-author Sean Hayden of the Northwest Conservation District.
- "**Out in the Open; Creating a Stormwater Park in the Heart of a Community**" published in the April 2013 issue of WaterWorld by Pennwell Corporation.
- "**Creating a Stormwater Park in the City Meadow of Norfolk, Connecticut**" published in the July/August 2013 edition of Land and Water

Volunteer Organizations

- President (elected 11/2013) and Connecticut Representative to the Board of Directors for the Northeast Chapter of IECA, (Chairman of 2012 Annual Conference to be held in Fishkill, NY)
- Chairman, Water Pollution Control Authority for the Town of Southbury

- Alternate member of Inland Wetlands Commission Town of Southbury (served three years)
- Northwest Conservation District Board of Directors (served 18 months)

Software Development

Developed a proprietary software application called **A**ssessment of **P**ollutant **L**oads and **E**valuation of **T**reatment **S**ystems (**A.P.L.E.T.S.**). This application calculates the pollutant loads for current and future land use conditions for the seven most common pollutants in non-point source runoff (TSS, TP, TN, Zn, Cu, TPH, & DIN) for a total of twenty two different types of land uses. The application then allows the evaluation of the effectiveness of thirty four Conventional and Low Impact Development treatment systems in removing these pollutants. Up to four treatment systems can be used in a row as a treatment train to achieve water quality goals.

Future Presentations

- Steve will be making two presentations at the 2019 Annual Conference of IECA being held in Denver, CO in February 2019. The presentations are entitled "A Study on Introduction Plan of Low Impact Development Techniques for Widespread Application in South Korea" and "If LID is so easy to implement, how come we keep getting it wrong". (https://www.eventscribe.com/2019/IECA/)

Invited Speaker Presentations:

- Steve made the following presentations at **St. Andrews University in Scotland** on October 19th for the Sustainable Development program. The first presentation is entitled "Improving the environment with Low Impact Sustainable Development Strategies". The second presentation is entitled "Addressing Water Quality and Runoff Issues in a changing weather world".
- Steve was invited by Dr. Jae Ryu of the University of Idaho Water Center to make a presentation entitled "Designing Low Impact Development treatment systems for **Urban & Agricultural Environments" at the Annual US-Korea Conference on Science, Technology, and Entrepreneurship** being held in Atlanta, Georgia on July 29 to August 1, 2015. (http://www.ukc.ksea.org/UKC2015/)
- Steve was invited by the Lake George Waterkeeper to make a presentation entitled "Applying LID Concepts in the Real World" at the 5th Annual Low Impact Development Conference being held in Lake George, NY on May 7, 2015. (http://fundforlakegeorge.org/2015LID)
- Steve was invited by Dr. Hyunsuk Shin and made a presentation entitled "Real Adaptation and Implementation of GI and LID Technology in USA" at the **World Water Forum** (http://eng.worldwaterforum7.org/main/) being held in Daegu, South Korea on April 14, 2015.

- Steve prepared a presentation for a workshop to civil and environmental engineering students at **Pusan National University** (http://www.pusan.ac.kr/uPNU_homepage/kr/default.asp) in Busan, South Korea on April 17, 2015 entitled "Designing LID System, What do you need to know and why".

- Steve was invited by Dr. Hong-Ro Lee of Kunsan National University and made a presentation entitled "Understanding Low Impact Development in the Urban-Rural Interface" for the **Ariul Brainstorming Working Group** on April 16, 2015 in Gunsan, South Korea. It will focus on how

Low Impact Development concepts can be applied to made land areas filled in off the west coast of South Korea to address water quality issues.

- Steve was an invited speaker at the **2014 Low Impact Development Conference** sponsored by the Lake George Waterkeeper and the Fund for Lake George in Lake George, NY on May 1, 2014 for land use professionals and regulatory agencies. He will be presenting case studies focusing on the application of LID concepts for commercial and residential projects.

- Steve was invited by Justin Kenney, Green Infrastructure Coordinator of the Vermont Department of Environmental Conservation Watershed Management Division to present an eight hour workshop entitled "From Bioretention to Permeable Pavement: An In-depth Introduction to Low Impact Development and Green Stormwater Infrastructure" in Montpelier, Vermont on December 5, 2013. The presentation was hosted by the **Vermont Green Infrastructure Initiative** with support from the following Vermont Agencies and Divisions; **Building and General Services, Ecosystem Restoration Program and Agency of Transportation.**

- Steve was invited to attend and present on the Application of LID Concepts for the Urban Environment and LID Case Studies at the 2nd Low Impact Development, Stormwater Management Forum hosted by the **Land & Housing Institute, Korean Land & Housing Corporation** to be held in South Korea in on October 31, 2013. He also made presentations at the **Korean Institute of Construction Technology** and **Pusan National University** on various aspects of LID during this time.

- Steve was an invited speaker at the **2013 Low Impact Development Conference** sponsored by the Lake George Waterkeeper and the The Fund for Lake George in Lake George, NY on May 2, 2013 for land use professionals and regulatory agencies. Over 80 design professionals and regulatory people were in attendance. He made a presentation entitled "Barriers to the implementation of LID".

- Steve was an invited presenter at a closed-meeting of the **National Association of Home Builders (NAHB) and the Water Environment Federation (WEF)** on October 10, 2012 focusing on progressive stormwater management. The presentation focused on the application of LID strategies on actual development projects and discussed the hydrologic performance and cost effectiveness of LID design.

- Steve was the invited presenter for a 1-hour long webinar presented by **Stormwater Solutions and Stormwater USA** on Low Impact Development and the Basics of Bioretention held on September 18, 2012. Over 760 individuals watched the webinar.

- Steve was an invited speaker at and **EPA/WEF Stormwater Technical Meeting** on July 18, 2012 in Baltimore, MD to discuss the application of Low Impact Development strategies for actual projects with a focus on cost effectiveness when compared to conventional stormwater management as well as field performance of the LID designs. The purpose of this meeting was to assist EPA in the development of a National Stormwater Rule.

- Site Design using Low Impact Development Strategies and What are the impacts of Impervious Cover on Water Quality and Quantity were presented at a workshop entitled "Challenges and Solutions using Low Impact Development", sponsored by the **Lake George Waterkeeper** in Lake George, NY on May 5, 2011 for land use professionals and regulatory agencies. 90 design professionals and regulators in attendance.

- Steve was an invited speaker at the **2012 Low Impact Development Seminar** sponsored by the Lake George Waterkeeper in Lake George, NY on April 25, 2012 for land use professionals and regulatory agencies. 100 design professionals and regulatory people were in attendance. He made a presentation entitled "The Hydrologic Benefits of Vegetation in Site Design".

Conference Presentations:

- Steve made a presentation entitled "LID in China and South Korea" at the 2018 Annual Conference of the Northeast Chapter of IECA in Concord, NH on October 1, 2018.
- Steve made a presentation entitled "If LID is so easy to implement, how come we keep getting in wrong" at the **2018 International Low Impact Development** conference being held in Nashville, TN on August 12 – 15, 2018. The conference is sponsored by ASCE and EWRI. (https://www.lidconference.org/)
- Steve made two presentations at the **2018 TRIECA Conference** being held on March 21 & 22, 2018 at the Pearson Convention Center in Brampton, Ontario. The presentations are entitled "Addressing Stormwater in China with Low Impact Development" and "Implement Low Impact Development in South Korea." This conference is sponsored by the Toronto and Region Conservation Authority and the Canadian Chapter of the International Erosion Control Association.
- Steve made the following presentations at the **2018 IECA Annual Conference** being held in Long Beach, CA in February of 2018. The presentations are entitled "How Low Impact Development strategies can mitigate high intensity rainfall events" and Designing Low Impact Sustainable Development treatment systems for Agricultural Environments".
- Steve was invited by the Dylan Drudul, President of the Mid-Atlantic Chapter of IECA to present the keynote address at a one day event called "Sediment Control Innovations Roadshow on July 14th in Columbia, Maryland. The keynote is entitled **"A Worldwide Perspective on Municipal Stormwater Issues".**
- Steve made a presentation entitled **"Designing LID Systems: What do you need to know and why"** at the 27th Annual Nonpoint Source Pollution Conference being held in Hartford, CT on April 20-21, 2016 as sponsored by the New England Interstate Water Pollution Control Commission.
- Steve will be presenting four one-hour long webinars through Halfmoon Seminars on Low Impact Development. The first entitled **"Introduction to Low Impact Development"** will be on May 10, 2016 at 12 pm. The second entitled **"Bioretention System Design"** will be offered on May 10, 2016 at 1:30 pm. The third entitled **"Applying LID Concepts to Residential Development"** will be offered on May 12, 2016 at 12 pm. The fourth entitled **"LID Case Studies"** will be offered on May 12, 2016 at 1:30 pm.
- Steve will be making a presentation entitled **"Designing LID Systems: What do you need to know and why**" at the UKC2016 conference, sponsored by KSEA (Korean-American Scientists and Engineers Association) at the Hyatt Regency DFW in Dallas, Texas, August 10 – 13, 2016.
- Steve made five presentations at the **2016 Environmental Connection** conference by IECA (www.ieca.org) being held in San Antonio, Texas on February 16 – 19, 2016. The presentations were entitled "Designing LID Systems: What do you need to know and why", "Construction Site Stormwater: The Ignored Problem", "Solving Construction Stormwater Problems in the Field", "Developing Effective LID Municipal Regulations", and "LID Demonstration Projects in Connecticut, a study of Contrasts".
- Steve made two presentations at the **EPA Region Stormwater Conference 2015** (http://epa.gov/region6/water/npdes/sw/ms4/2015conference/index.html) being held in Hot Springs, AR on October 18-23, 2015. The presentations are entitled "Designing LID systems: What do you need to know and why" and "Designing LID treatment systems for Urban and Agricultural Environments."

- Steve made a presentation entitled "Applying LID strategies to residential and commercial developments to address water quality and runoff volumes" at the KSEA Northwest Regional Conference 2015 held at the Idaho Water Center in Boise, Idaho on October 11, 2015.
- Steve made a presentation entitled "Solving Construction Stormwater Problems in the Field" at **WEFTEC 2015** (http://www.weftec.org) in Chicago, IL on September 29, 2015.
- Steve made three presentations entitled: "Korean GI/LID Research Facility", Applying LID concepts to High Density Residential Developments, and Municipal LID Regulations" at the 2015 Environmental Connection IECA Annual Conference being held in Portland, Oregon on February 16 – 18, 2015. He also presented a half day workshop entitled: "Designing LID Projects". He moderated an Expert Panel on Low Impact Development with Seth Brown, (Water Environment Federation), Bob Adair (Construction Ecoservices, Inc.) and Roger Sutherland (AMEC)

- Steve made two presentations at International Low Impact Development Conference 2015 in Houston, Texas which is sponsored by ASCE-EWRI. The presentations are entitled "Korean GI/LID Research Facility", and "LID Demonstration Projects in Connecticut: The Good and the Bad".

- Steve made presentations entitled "Overview of Low Impact Development" and "The Application of Low Impact Development Strategies for Land Development Projects" along with Dr. Jae Ryu of the University of Idaho and Dr. Hyun-Suk Shin of Pusan National University at the annual meeting of the **American Water Works Association** in Tyson Corners, VA on November 6, 2014.

- Steve made two presentations entitled "Construction Site Stormwater: The Ignored Problem" and "Applying LID Concepts to High Density Residential Development" at the **2014 Annual Conference and Trade Show of the Northeast Chapter of IECA** held at Lake Morey, Vermont on November 4 – 5, 2014.

- Steve made the following presentations entitled: "A Case Study – Southbury Medical Facility and Applying LID concepts on undeveloped land and in the urban environment" at Municipal Wet Weather Stormwater Conference, hosted by the **Southeast Chapter of IECA** in Charlotte, NC on August 18th and 19th, 2014.

- Steve made the following presentations: "The Incorporation of LID on Affordable Housing Projects, A Case Study – Southbury Medical Facility and LID' and Municipal LID Regulations" at the **16th Annual EPA Region 6 Stormwater Conference** sponsored by the South Central Chapter of IECA in Fort Worth, TX on July 27th through August 1st, 2014.

- Steve made oral presentations at the **2014 Environmental Connection** sponsored by the International Erosion Control Association in Nashville, Tennessee on February 25 – 18, 2014. The presentations were entitled "A Case Study – Southbury Medical Facility and LID", "The Implementation of the Highland Estates Detention Basin Retrofit water quality impairment in Northfield Lake", and "Creating Effective Municipal LID Regulations".

- Steve co-presented an all day workshop on Low Impact Development with Jamie Houle of the University of New Hampshire Stormwater Center at the **2013 International Erosion Control Association Northeast Chapter Conference and Trade Exposition** on November 19 – 21, 2013 in Warwick, RI.

- Steve made three oral presentations at the **2013 International Low Impact Development Symposium** held at the Saint Paul RiverCentre in Saint Paul, Minnesota on August 18 – 21, 2013. The presentations were entitled "A Case Study – Southbury Medical Facility and LID", "LID

regulations in Connecticut: The Long and Tortured Road", and "Creating a Stormwater Park in the City Meadow of Norfolk, Connecticut."

- Steve presented two papers at the **2013 EWRI World Environmental and Water Resources Congress** held in Cincinnati, Ohio on May 19- 23, 2013. The papers are entitled: "Municipal LID Regulations - What is important to include to be successful?" and "Creating a Stormwater Park in the City Meadow of Norfolk, Connecticut". http://content.asce.org/conferences/ewri2013/index.html

- Steve made a presentation at the **Soil and Water Conservation Society Winter Conference** held in Berlin, Connecticut on February 15, 2013. The presentation focused on erosion and sedimentation control issues with Low Impact Development treatment systems.

- Steve presented two papers at the **2013 Environmental Connection** held in San Diego, CA on February 10 – 13, 2013. The papers are entitled "LID Demonstration Project for Seaside Village in Bridgeport, Connecticut" and "Creating a Stormwater Park in the City Meadow of Norfolk, Connecticut". He also presented a full day LID workshop entitled "Next Generation Low Impact Development and Meet Today's Needs" and a half day workshop on Low Impact Development covering Environmental Site Design, Water Quality Issues, Pollutant Loading Analyses, Designing different types of LID treatment systems and actual case studies.

- Steve made three presentations at the **2012 Annual Conference of the Northeast Chapter of IECA** in Fishkill, NY on November 7, 8, & 9, 2012. The presentations are entitled: "LID Demonstration Projects in Connecticut, A Study of Contrasts, Environmental Site Design and LID Hydrologic Issues, and Siting and Designing LID Treatment Systems with Case Studies"

- Steve made two oral presentations entitled "Applying Environmental Site Design Strategies to Design a Residential Subdivision" and "The incorporation of LID on Affordable Housing Projects" at the **2012 Ohio Stormwater Conference** in Toledo, Ohio sponsored by the Ohio Stormwater Association on June 7th and 8th, 2012.

- Presented two papers at the **ASABE Watershed Technology Conference** in Bari, Italy, May 28 – 30, 2012. The papers were entitled "LID Demonstration Project for Seaside Village in Bridgeport, Connecticut" and "The creation of a Stormwater Park in the City Meadow of Norfolk, Connecticut".

- Steve made one oral presentation entitled "LID Demonstration Project for Seaside Village in Bridgeport, Connecticut" and presented one poster entitled "The Incorporation of LID on Affordable Housing Projects" at the **2012 World Environmental & Water Resources Congress** in Albuquerque, New Mexico sponsored by EWRI/ASCE on May 20 - 24, 2012.

- "Stormwater Retrofit of Highwood Estates Detention basins to address Water Quality Issues and How the application of Environmental Site Design Strategies can provide a resource for carbon sequestering" were presented at the **2011 International Erosion Control Associated Northeast Chapter Annual Conference** on December 1 – 3, 2011 at the Crowne Plaza Hotel in Natick, Massachusetts.

- Stormwater Retrofit of Highwood Estates Detention Basins to enhance Water Quality Benefits; A Low Impact Development (LID) Model Ordinance and Guidance Document and The Farmington River Enhancement Grants: A tale of three towns and the path to Low Impact Development were presented at the **Philadelphia Low Impact Development Symposium "Greening the Urban**

Environment" in Philadelphia, PA (September 2011) sponsored by EWRI, Villanova University, North Carolina University and the University of Maryland.

- Stormwater Retrofit of Highwood Estates Detention Basins to enhance Water Quality Benefits; The Farmington River Enhancement Grants: A tale of two towns and the path to Low Impact Development and A Low Impact Development (LID) Model Ordinance and Guidance Document was presented at the **EWRI/ASCE 2011 World Environmental & Water Resources Congress** in Palm Springs, CA (May 2011).

- Stormwater Retrofit of Highwood Estates Detention Basins to enhance Water Quality Benefits was presented at the "Annual Nonpoint Source Pollution Conference", sponsored by the **New England Interstate Pollution Control Commission** in Saratoga Springs, NY, on May 17-18, 2011.

- Stormwater Pollutant Load Modeling presented at the **Northeast Chapter of IECA Annual Conference** at the University of New Hampshire Stormwater Center in Durham, NH (December 2010).

- How the application of Environmental Site Design Strategies and Low Impact Development Storm Water Treatment Systems can mimic the Natural Hydrologic Conditions in a watershed and provide a resource for carbon sequestering and The Importance of Assessing Pollutant Loads from Land Development Project and the Design of Effective Storm Water Treatment Systems at the **EWRI/ASCE Watershed Management Conference** in Madison, WI (August 2010).

- The Tolland Low Impact Development Design Manual: The Changing Paradigm for Land Development, The application of Environmental Site Design Processes to design a residential subdivision and A Low Impact Development (LID) Model Ordinance and Guidance Document at the **ERWI/ASCE 2010 World Environmental and Water Resources Congress** in Providence, RI (May 2010).

- The application of Form-Based Zoning and Low Impact Development for the Revitalization of the Town Center of Simsbury, Connecticut and The Integration of Low Impact Development to enhance the application of Smart Code Zoning to create a Gateway District to the Historic Town Center of Tolland, Connecticut at the **EWRI/ASCE 2010 International Low Impact Development Conference** in San Francisco, CA (April 2010).

- The application of Environmental Site Design Processes to design a residential subdivision and Assessing Pollutant Loads and Evaluation of Treatment Systems to achieve Water Quality Goals for Land Development Projects at the **EWRI/ASCE 2009 World Environmental & Water Resources Congress** in Kansas City, Missouri (May 2009).

- Ahead of the Curve – Tolland, CT adopts Low Impact Development Regulations and Preparing a Pollutant Loading Analysis for Land Development Projects at the **Urban Water Management Conference** in Overland Park, KS sponsored by National Association of Clean Water Agencies (NACWA) and the City of Independence Water Pollution Control Department (March 2009).

- Ahead of the Curve – Tolland, Connecticut adopts Low Impact Development Regulations and Trade Winds Farm – Winchester, Connecticut – How to create a LID subdivision along with the preparation of a poster on Preparing a Pollutant Loading Analysis for Land Development Projects at **EWRI/ASCE 2008 International Low Impact Development Conference** in Seattle, WA (November, 2008).

- Trade Winds Farm – Winchester, Connecticut – How to create a LID subdivision and Preparing a Pollutant Loading Analysis for Land Development Projects at the **IECA Northeast Chapter's Annual Conference & Trade Exposition** in Portland, ME (October, 2008).

- The Preparation of a Valid Pollutant Loading Analysis at the **National StormCon 2008 Conference** in Orlando, FL (August, 2008).

- Panelist with Linda Farmer, AICP for Profiles of Partnerships for Addressing NPS Pollution at **NEIWPCC Annual Non-point Source Pollution Conference** in Groton, CT (May, 2008).

Workshop Presentations:

- Steve presented a webinar entitled "Construction Stormwater Regulation Strategies: Best Practices to Assure NPDES Compliance" on Thursday, November 12, 2015 at 2:00 pm to 3:00 pm eastern time. The webinar is sponsored by Business and Legal Resources (www.blr.com).
- Steven presented a full day workshop entitled "Stormwater Management 2015" in Columbia, Maryland on August 13, 2015 which focused on applying the State of Maryland Stormwater Manual. The workshop was sponsored by Halfmoon Seminars, LLC and 113 people attended the workshop.

- Steve presented a full day workshop on "Stormwater Regulations in Connecticut", sponsored by Halfmoon Seminars, LLC in North Haven, Connecticut on June 25, 2014. More than 30 engineers and landscape architects attended the workshop.

- Steve was the facilitator in a live chat as part of the Stormwater Solutions Virtual Trade Show on April 2, 2014. The topic of the live chat will be LID with a focusing on Bioretention systems.

- Steve made a presentation entitled "What is Low Impact Development and how do you apply it to residential projects" for the Connecticut Chapter of the American Institute of Architects in New Haven, Connecticut on April 22, 2014.

- Steve made a presentation entitled "Wastewater to Stormwater; Designing a subsurface flow gravel wetlands" at the annual meeting of the Connecticut Association of Wetland Scientists on March 20, 2014 in Southbury, Connecticut.

- Steve made a presentation entitled " Low Impact Development and the Connecticut General Stormwater Permit" at the annual meeting of the Southern New England Chapter of the Soil and Water Conservation Society on March 14, 2014 at Eastern Connecticut State University.

- He co-taught an ASCE Short Course entitled, "Introduction to Low Impact Development" with Mike Clar at the 2013 Low Impact Development Symposium held in St. Paul, Minnesota on August 18, 2013.

- Steve presented a workshop on Low Impact Development to the Town of Naugatuck Inland Wetlands Commission on June 5, 2013 to demonstrate how the implementation of LID can reduce stormwater impacts in the urban area of the community.

- Steve presented a webinar entitled "The Basics of Low Impact Development on Wednesday, April 17, 2013. More information is available at http://www.ieca.org/education/webinar/livewebinars.asp

- Steve presented a webinar entitled "Changing the Regulatory Framework to Adopt LID Strategies" on Thursday, March 7, 2013 and on Thursday, August 8, 2013 from 11:30 am to 1:00 pm through **ASCE and EWRI.** Link for more information: http://www.asce.org/Continuing-Education/Brochures/Webinars/ChangingRegulatoryFrameworkLIDStrategies/#Purpose

- Steve presented a three hour workshop on Low Impact Development on June 5, 2012 at the Oxford town hall for municipal land use staff and officials at the request of the **Oxford Inland Wetlands and Watercourses Commission**. Approximately 20 individuals attended the workshop.

- Steve presented an eight hour short courses on Low Impact Development at the **EWRI/ASCE 2011 World Environmental & Water Resources Congress** in Palm Springs, CA (May 2011). The following topics will be covered: Understanding and Implementing Principles of Low Impact Development, Applying LID Strategies to a Site, Low Impact Development Hydrologic Considerations, The Regulatory Framework and LID, LID Integrated Management Practices, Erosion and Sedimentation Controls for the Implementation of LID Practices and Case Studies (Applying LID and Regulations). 12 attendees took the course, including professors from Mississippi State University, Oklahoma State University, Adelaide University (Australia) and Pusan National University (South Korea).

- Understanding and Implementing Principles of Low Impact Development, Applying Low Impact Development to a Site, Low Impact Development Hydrologic Considerations, Low Impact Development Integrated Management Practices, Erosion and Sediment Control for the Implementation of Low Impact Development Practices, and Case Studies of LID (Residential and Commercial) at workshops on Low Impact Development sponsored by **HalfMoon, LLC** (https://www.halfmoonseminars.com) in Albany, NY, Ronkonkoma, NY, North Haven, CT, Manchester, NH, Nanuet, NY, Cleveland, OH, Natick, MA, Portland, ME Fort Washington, PA, Springfield, MA, Wilmington, DE, White River Junction, VT, Somerset, NJ, and White Plains, NY for continuing education credit for design professionals. A total of 322 land use professionals have attended these workshops.

- Pollutant Loads and the Design of Effective Stormwater Treatment Systems was presented at the Virtual H2O conference on February 22, 2011 as presented by **PennWell Publishing**. 25 professionals in attendance.

- LID Stormwater Treatment Systems: Siting, Design and Installation for Maximum Environmental Benefit. What are the aesthetic, financial and maintenance implications? presented at a seminar for the **AIA Connecticut, Committee on the Environment** in New Haven, CT (December 2010). 70 architects in attendance.

- Low Impact Development and the Environmental Site Design process to create sustainable sites at a seminar for the **AIA Connecticut, Committee on the Environment** in New Haven, CT (September 2010). 40 architects in attendance.

- Workshop entitled Using Environmental Site Design Strategies and LID stormwater systems for commercial development at the **Connecticut Conference on Natural Resources** at the University of Connecticut (March 2010). 10 design professionals and regulatory staff in attendance.

- Implementing Low Impact Development in Your Community for the **Connecticut Technology Transfer Center** in Glastonbury, CT (November, 2009). 40+ professionals in attendance.

- What towns can do to encourage LID at the "Low Impact Development Forum" presented by the **Housatonic Valley Association** in Shelton, CT. (October 2009). 12 professionals in attendance.

- Town of Tolland, CT; Low Impact Development Regulations and Design Manual at the **Community Builders Institute** for the workshop entitled: "Swift, Certain & Smart: Best Practices in Land Use" (May 2009). 30+ professionals in attendance.

- Low Impact Development, Environmental Site Design and Water Quality issues and strategies to local municipalities (**Greenwich, and Old Lyme**) to provide an educational opportunity about the many benefits of Low Impact Development in 2009. 30+ design professionals, regulatory commissioners and staff in attendance for each presentation.

- Low Impact Development, Environmental Site Design and Water Quality issues and strategies to local municipalities (**Bolton, Farmington, and Guilford** to date) on a pro bono basis to provide an educational opportunity about the many benefits of Low Impact Development in 2009. 25+ design professionals, regulatory staff and commission members in attendance for each presentation.

- Workshop entitled Using Environmental Site Design Strategies to create a residential subdivision at the **Connecticut Conference on Natural Resources** at the University of Connecticut (March 2009). 20 design professionals and regulatory staff in attendance.

- The Need for Pollutant Loading Analyses for Land Development Projects to storm water engineers at **CT DEP** (March 2009). 6 DEP staff in attendance.

- A review of existing land use regulations and storm water management issues for the Middle Quarter Districts in Woodbury, CT and how the implementation of Environmental Site Design and Low Impact Development strategies can improve water quality of storm water runoff for the Woodbury land use agencies (August 2008). 15 regulatory commission members in attendance.

- Low Impact Development at meeting of the **Connecticut Association of Zoning Enforcement Officers** (October 2007). 30+ professionals in attendance.

- Low Impact Development and adoption of LID regulations by municipalities at workshops of the **Land Use Leadership Alliance (LULA)** (2007, 2010 and 2011). 20+ professionals in attendance at each presentation.

- Stormwater management and Low Impact Development at workshop sponsored by the **Northwest Conservation District** held for land use officials (March 2006). 20+ professionals in attendance.

Conferences Attended

- Bioretention Summit: Ask the Researcher – Annapolis, MD by the University of Maryland (Dr. Alan Davis), North Carolina State University (Dr. Bill Hunt) and Villanova University Stormwater Partnership (Dr. Rob Traver) – (July 2010).

- Workshop at the University of New Hampshire Stormwater Center on permeable pavements. This full-day training included field visits to a variety of on-the ground porous pavement installations throughout the region. Participants learned key design principles necessary to successfully design, evaluate, specify, and install porous pavement for stormwater management. (December 2009).

- Two workshops at the University of New Hampshire Stormwater Center in Durham, NH to observe conventional and Low Impact Development storm water treatment systems in operation. The Stormwater Center is independently verifying the effectiveness of the various treatment systems to remove pollutants from runoff and reduce impacts associated with storm flows. (March 2006 and May 2007).

- 2ND National Low Impact Development Conference – North Carolina State University held in Wilmington, NC, (March 2007).

- Designing Bio/Infiltration Best Management Practices for Stormwater Quality Improvement – University of Wisconsin (Madison, WI) (November 2005).

- Stormwater Design Institute – Center for Watershed Protection (White Plains, NY), (December 2004).

- Engineering and Planning Approaches/Tools for Conservation Design – University of Wisconsin (Madison, WI) (December 2003).

- Law for Design Professionals in Connecticut – Lorman Education Services in Trumbull, CT (September 2002).

- On-site Wastewater Facility Design – University of Massachusetts in Amherst, MA (May 2002).

- The Northeast Onsite Wastewater Short Course & Equipment Exhibition – New England Interstate Water Pollution Control Commission in Newport, RI (March 2002).

- Designing On-site Wetland Treatment Systems, University of Wisconsin, (Madison, WI) (October 1999).

- Cost Effective Drainage System Design – University of Wisconsin (Atlanta, GA) (November 1997).

- Treatment Wetlands, University of Wisconsin, (Madison, WI). "Creating and Using Wetlands for Wastewater Disposal and Water Quality Improvement" (April 1996).

- Alternative On-site Wastewater Treatment Systems, New England Intrastate Pollution Control Commission's On-Site Wastewater Task Force in Westford, MA (November 1994).

- Stormwater Quality, University of Wisconsin, (Portland, ME). "Designing Stormwater Quality Management Practices" (June 1994).

LOW IMPACT SUSTAINABLE
LID
DEVELOPMENT
TRINKAUS ENGINEERING

LOW IMPACT SUSTAINABLE DEVELOPMENT PROJECTS

LID Regulations and Design Manuals

- **Town of Tolland. CT –** Prepared amendments to Town of Tolland Zoning, Subdivision, Inland Wetland regulations and Road Design Manual to incorporate Low Impact Development standards. Wrote "Design Manual – Low Impact Development – Storm Water Treatment Systems – Performance Requirements – Road Design & Storm Water Management" prepared for the Town of Tolland; October 2007. The Town of Tolland was awarded the Implementation Award by the CT-APA for the LID regulations and design manual in December 2008.

- **Town of Plainville, CT –** Planimetrics was the lead consultant on this project. This office performed the technical regulatory audit to identify barriers to the implementation of LID. These barriers were removed from the regulations to provide for the implementation of LID. A LID design manual was written by Steve Trinkaus to address specific development/stormwater issues for the Town of Plainville. The regulatory changes and LID manual were adopted by the Planning and Zoning Commission in September 2010. This work was funded by the Farmington River Enhancement Grants from CT DEP.

- **Town of Harwinton, CT –** In conjunction with Planimetrics of Avon, CT, the existing land use regulations were evaluated for barriers to the implementation of Low Impact Development (LID). The project team suggested changes to the land use regulations to encourage the application of LID in the community. Steve Trinkaus defined design processes and strategies to encourage the implementation of LID in the town. This work was funded by the Farmington River Enhancement Grants from CT DEP.

- **Town of East Granby, CT –** Planimetrics was the lead consultant on this project. This office performed the technical regulatory audit to identify barriers to the implementation of LID. These barriers were removed from the regulations to provide for the implementation of LID. Steve Trinkaus prepared a LID Design Manual and LID Educational document for the town working with Gary Haynes, the town planner. This work was funded by the Farmington River Enhancement Grants from CT DEP.

LID Projects

- **Garden Homes Management –** Westport, Connecticut – 48 unit residential apartment building being developed under 8-30g (affordable housing) on 1 acre site directly tributary to West Branch of the Saugatuck River. All construction activities are located outside regulatory setbacks to tidal wetland and 100-year flood boundary. Stormwater management system was designed to fully infiltrate the runoff for all storm events up to and including the 100-year event and reduce pollutant loads to existing levels as wooded parcel.

- **Jelliff Mill, LLC** – New Canaan, Connecticut: Redesigned the site layout to create ten single family residential units on a site overlooking the restored historic Jelliff Mill dam on the Noroton River. The site design uses two sections of permeable pavement and a Bioretention system to infiltrate the runoff from the proposed impervious areas on the site. Due to the presence of sand and gravel soils, all runoff from the impervious areas will be infiltrated up to and including the 25-yr storm event (5.7" of rain/24 hrs). Fully constructed and occupied.

- **SRG Family, LLC** – Southbury, Connecticut: Design final site grading for 38,000+ sq.ft. Medical services building and approximately 225 parking spaces in order to maintain overland flow patterns. Designed multiple LID treatment systems consisting of bioswales with weirs, Bioretention systems and Permeable Pavement (asphalt) to handle runoff from all impervious area on the project site. The LID treatment systems are capable of fully infiltrating the runoff from a 50-yr storm event will virtually eliminating the discharge of any pollutants to the adjacent wetland area. Currently pending before Inland Wetlands Commission for modification of original approval.

- **Farmington River Watershed Association** – Winchester, Connecticut: Designed stormwater retrofit for existing 1 acre paved parking area at the science building of the Northwest Community College to treat runoff prior to discharge into the Still River. Retrofit consists of forebay and Bioswale to treat runoff from parking area and building roof. Currently at Bid stage.

- **Garden Homes Management –** Southport, Connecticut: Designed site to support 96 unit apartment building and 115 parking spaces. Site contains both freshwater and tidal wetlands. Stormwater management design required to provide Groundwater Recharge Volume & Water Quality Volume in addition to reducing the post-development peak rate of runoff from the 10-yr rainfall event to the pre-development peak rate of runoff from the 2-yr rainfall event. The stormwater management design includes grassed swales, Bioretention systems and underground concrete galleries to meet all of these stormwater requirements. Due to favorable soils on the site, the site will likely be a zero discharge site. Currently under legal review.

- **Garden Homes Management** – Milford, Connecticut: Designed site to support 257 unit apartment building with 295 parking spaces. Stormwater management design required to provide Groundwater Recharge Volume & Water Quality Volume in addition to reducing the post-development peak rate of runoff from the 25-yr rainfall event to the pre-development peak rate of runoff from the 25-yr rainfall event. The design utilizes a Bioretention system, two underground galleries systems as well as a small detention basin to meet all of the stormwater requirements. Currently under legal review.

- **Garden Homes Management** – Milford, Connecticut: Designed site to support 21,888 sq.ft. building (three stories) containing 36 studio apartments and 45 parking spaces. Permeable pavement and Bioretention will be used on the site to treat runoff for water quality improvements along with reducing runoff volume from the 1-yr to 100-yr storm event. Construction complete and project ready for occupancy.

- **Quickcomm, Inc. –** Newtown, CT**:** Design a parking facility for approximately 140 vehicles to serve an existing corporate use. Runoff from the entire parking facility will be directed to one of seven Bioretention systems. Water quality of the runoff will be improved by the filtration through a specialized soil media and will then infiltrate into the underlying soils. Due the presence of sand and gravel soils, the Bioretention systems will fully infiltrate all runoff up to and including a fifty-year design storm (6.5" of rain/24 hours). Land use approvals obtained in the fall of 2012 and work completed in the fall of 2013.

- **Garden Homes Management** – Fairfield, Connecticut: Designed site to support 32,592 sq.ft. building (three stories) containing 54 studio apartments and 68 parking spaces. Permeable pavement will be used for majority of parking facility. Roof drains will also be directed to permeable pavement system for water quality improvement. Reservoir layer was sized to fully contain 1.7" of runoff from contributing impervious area. By using a raised underdrain an anaerobic condition will be maintained in the bottom of the reservoir, thus providing denitrification of Total Nitrogen prior to discharge to tidal section of Rooster River. Construction complete and project ready for occupancy.

- **Garden Homes Management** – Oxford, Connecticut: Design site plan for 126 units of manufactured housing on 41+ acres. Stormwater management is achieved by the use of linear Bioretention systems (Bioswales) along both sides of all interior roads. After treatment in Bioswales, all runoff is directed to standard detention basins to provide peak rate attenuation from the 2-year to 100-year rainfall event. Approved by Inland Wetlands Agency, Denied by Planning and Zoning Commission. Currently under legal appeal in court.

- **Compton Family Trust** – New Hartford, Connecticut: Design two wet swales systems to convey and filter runoff from road which is currently discharged into West Hill Lake via a paved swale. West Hill Lake has very good water quality and the owner desires this work on this property to become a template for other homeowners on West Hill Lake to prevent adverse impacts of stormwater on the water quality of the lake. Received all necessary land use approvals. Construction to commence in the summer of 2012.

- **Highwood Estates** – Thomaston, Connecticut: Design retrofits for two existing failing detention basins serving existing 50 lot residential subdivision. Retrofits were designed using LID techniques to improve water quality reaching Northfield Brook, an impaired waterway. The larger basin was converted to an Extended Detention Shallow Wetlands to significantly reduce pollutant loads. Due to a limited area, only a forebay and deep pool could be designed for the smaller basin, thus providing measurable improvements in water quality.

- **Farmington River Watershed Association** – Winchester, Connecticut: Design stormwater retrofits consisting of a Bioretention system at the Town of Winchester Wastewater Treatment Plant and a Bioswale at the Town of Winchester Public Drinking Supply facility. These projects are being funded as LID demonstration projects to increase public awareness of LID. The systems were installed in June 2012 and were featured in articles in the Republican American and Register Citizen newspapers.

- **Harwinton Sports Complex** – Harwinton, Connecticut: Redesign stormwater management system for indoor sports facility to use vegetated swales and Bioretention systems. Redesign site grading to eliminate all structural drainage in parking facility. Client saved over $ 40,000 on infrastructure costs by the use of LID treatment systems.

- **Holland Joint Venture, LLC –** Bridgewater, Connecticut: Prepared site plan for 28,000 sq.ft. industrial/light assembly use and 140 parking spaces on 10.94 acres. Utilize Environmental Site Design strategies to preserve large portions of site in natural condition, minimize impacts due to site disturbance, and minimize impacts to wetland/watercourse system by access driveway. Designed five Bioretention systems for storm water management and pollutant removal from all impervious areas.

- **Goodhouse Flooring, LLC** – Newtown, Connecticut: Design site to accommodate 8,800 commercial building and associated driveway and parking areas on 1.0 acre site. Designed eight Bioretention systems to handle runoff from all impervious surfaces. Analyze and demonstrate that State of Connecticut water quality goals will be achieved for the site design.

- **Trade Winds Farm** – Winchester, Connecticut: 24 lot Open space subdivision on 104+ acres of land. Performed all civil engineering design work for project. Notable feature of project is the preservation of 64+ acres of the site as dedicated Open Space. Many LID strategies such as Environmental Site Design, site fingerprinting, volumetric reduction and water quality improvements

were incorporated into site design. Storm water treatment systems utilized vegetated basins, vegetated swales with gravel filter berms, emergent marsh, Bioretention systems, linear vegetated level spreader, and meadow filter strips.

- **Northern View Estates** – Sherman, Connecticut: Five lot subdivision with private road. Design has no direct wetland impacts and only minor intrusions into defined 100' upland review area. Low Impact Development systems, such as vegetated swales and Bioretention were used to treat post-development runoff while maintaining existing drainage patterns to the maximum extent possible.

- **Mill River** – New Milford, Connecticut: Designed 14 lot open space subdivision on 68 acre site. Performed all civil engineering services for project. .LID treatment systems such as a permanent pond/emergent marsh system, linear biofiltration swale, and rain gardens were designed for the site.

- **Byron Avenue Cluster Development** – Ridgefield, Connecticut: Seven lot cluster subdivision on 4 acres. The Stormwater management system consisted of a road with no curbs, grassed swales and constructed wetland with detention to reduce pollutant loads and increases in the peak rate of runoff.

- **The Estates on the Ridge** – Ridgefield, Connecticut: 32 lot open space subdivision on 152+ acres. Over 80 acres of the site will be preserved as Open Space as part of this project. Stormwater will be treated by the use of rain gardens for roof drains, infiltration trenches for footing drains, emergent marsh systems and vegetated swales for conveyance and treatment of road runoff. Designed over 1 mile of proposed road for project. Designed bottomless culverts over several wetlands crossing to minimize direct impact on wetland areas.

- **G & F Rentals, LLC** – Oxford, Connecticut: By utilizing LID stormwater concepts such as grass filter strips, Bioretention in parking islands, Bioretention for roof drains, and infiltration trenches, a total of 54,000 sq.ft. of commercial office space along with 140+ parking spaces was placed on 10 acre site. The project also restored previously degraded inland wetlands on the site.

- **Dauti Construction – Edona Commons** – Newtown, Connecticut: Designed 23 unit affordable housing plan to minimize impacts on delineated wetland areas. Designed three construction wetland systems for the treatment of storm water runoff for water quality renovation.

- **American Dimensions, LLC** – New Milford, Connecticut: Redesigned the storm water treatment systems for a 7 lot residential subdivision. Rain gardens were designed to handle the runoff from all roof areas and proposed driveways. Each rain garden provided the required Water Quality Volume and Groundwater Recharge Volume as specified in the 2004 Storm Water Quality Manual. A Subsurface Gravel Wetland was designed to treat the full Water Quality Volume for runoff from adjacent roads network which drained through the subject property.

- **Molitero Residence** – New Fairfield, CT: Designed five Bioretention systems to mitigate both volumetric increases of runoff and address water quality issues for large building addition to single family residence on Candlewood Lake. Also designed landscape filter strip above lake edge to filter runoff from up gradient lawn area. Bioretention systems fully infiltrated 5" of rain in 24 hours from Hurricane Irene in August of 2011. Project was featured in newsletter of Candlewood Lake Authority to demonstrate the effectiveness of LID treatment systems in a lake environment.

- **Multiple single family residences** – Design Bioretention systems to mitigate volumetric increases of runoff due to increases of impervious cover on the lot for large building additions and new

construction including the reduction of volumetric increases up to the 25-yr event (5.7" of rain in 24 hours).

Residential Subdivisions

- **Stone Ridge Estates**, 59 lot residential open space subdivision, Ridgefield, Connecticut (Town of Ridgefield)
- **Oak Knoll**, 14 lot open space subdivision, Ridgefield, Connecticut (Mike Forbes)
- **Ward Acres Farm**, 12 lot open space subdivision, Ridgefield, Connecticut (Sturges Brothers, Inc.)
- **Horblitz Subdivision**, 13 lot open space subdivision, Ridgefield, Connecticut (John Sturges)
- **McKeon Subdivision**, 14 lot conventional subdivision, Ridgefield, Connecticut (McKeon Family Trust)
- **High Ridge Estates**, 5 lot subdivision in historic district, Ridgefield, Connecticut (Scandia Construction)
- **Millstone Court**, 7 lot conventional subdivision, Ridgefield, Connecticut (Sturges Brothers, Inc.)
- **Cricklewood Subdivision** – 12 lot conventional subdivision, Redding, Connecticut (Jay Aaron)
- **Spruce Meadows Subdivision** – 12 lot conventional subdivision, Wilton, Connecticut (Piburo Builders)
- **Noroneke Estates** – 12 lot open space subdivision, Ridgefield, Connecticut (John Sturges)
- **Lynch Brook Lane** – 7 lot open space subdivision, Ridgefield, Connecticut (Sturges Brothers, Inc.)
- **Ledgebrook Subdivision** – 27 lot conventional subdivision, Southbury, Connecticut (Conte Family Trust, LLC**)**
- **Seven Oaks** – 19 lot open space subdivision, Ridgefield, Connecticut (Basha Szymanska)
- **Applewoods** – 29 lot conventional subdivision, Bethel, Connecticut (Gene & Joe Nazzaro)

Third Party Engineering Reviews

- **Groton Open Space Association** – Wal-Mart Super center, Mystic Woods Age Restricted Development, and changes to stormwater standards in the Town of Groton regulations – Groton, Connecticut. Focus of review was on stormwater management plans to address water quality and runoff volumes per the CT DEP 2004 Storm Water Quality Manual as well as the adequacy of the erosion and sedimentation control plan for the proposed development.
- **Town of Tolland Planning & Zoning Commission** – Star Hill Athletic Complex with focus on water quality impacts on existing impaired waterway. Focus was on suggesting changes to stormwater management system to comply with recently adopted Low Impact Development requirements in the Town of Tolland.
- **Town of Newtown Inland Wetlands Commission** – Sherman Woods – 38 lot residential Subdivision with focus on stormwater management and water quality. Review stormwater management plan for compliance with CT DEP 2004 Storm Water Quality Manual to address water quality issues being directed to high quality wetland systems. Also review erosion & sedimentation control plan for adequacy and compliance with CT DEP 2002 Guidelines for Soil Erosion & Sediment Control.
- **Town of Winchester Inland Wetlands Commission** – 30,000 sq.ft. Commercial building with grading and stormwater management within 100-yr flood plain. Plan reviewed focused on impacts to floodway and 100-year flood plain as a result of the placement of significant fill within the flood plain.
- **Town of Southbury Inland Wetlands Commission** – 35,000 sq.ft. Medical office building proposed in close proximity to inland wetlands & watercourses. Review focus on the adequacy of the

stormwater management plan to address water quality and runoff volumes prior to discharge into on-site wetland areas.

- **Friends of Litchfield** – Stop & Shop proposal on existing retail site proposing an increase of impervious area of 1 acre directly draining into an aquifer protection area. Focus of review was on adequacy of stormwater management system to address water quality of runoff and prevent further off-site adverse impacts.
- **The Regency at Ridgefield** – Proposal for contractor's yard on steep slope immediately uphill of existing pond and wetlands. Project proposed removal of over 45,000 cubic yards of earth and rock to facilitate construction of building. Focus of review was on adequacy of erosion control and stormwater management plan to prevent discharges of pollutants to receiving pond.
- **Friends of Oswegatchie Hills Nature Preserve, Inc. and Save the River, Save the Hills, Inc**. – Review of preliminary site plan for 840 unit of affordable housing on a 230+ acre site directly adjacent to the Niantic River submitted for a zone change to the Planning and Zoning Commission. Focus of review was on stormwater management and impacts to down gradient wetlands, including the Niantic River.
- **Town of Brookfield Inland Wetlands Commission** – The Enclave at Brookfield, an affordable housing project with 187 units on 9.8 acres proposing filling of wetland, locating stormwater basin within inland wetland area and a significant increase of impervious. Review focused on adequacy of stormwater management system to address water quality, runoff volume and peak rate changes due to development in accordance with CT DEP 2004 Storm Water Quality Manual and local land use requirements; review of erosion & sedimentation control plan for compliance with CT DEP 2002 Guidelines for Soil Erosion & Sediment Control and local land use requirements.
- **Town of Brookfield Inland Wetlands Commission and Zoning Commission** – The Renaissance, an affordable housing project with 156 units of 5+ acres adjacent to the Still River replacing existing development on the site. Review focused on adequacy of stormwater management system to address water quality, runoff volume and peak rate changes due to development in accordance with CT DEP 2004 Storm Water Quality Manual and local land use requirements; review of erosion & sedimentation control plan for compliance with CT DEP 2002 Guidelines for Soil Erosion & Sediment Control and local land use requirements. Additionally, reviewed issues of development in the floodway and 100-year flood plain of the Still River.
- **Branford Citizens for Responsible Development** – Review of development plans for Costco Store and other commercial development on 45 acres in Branford, CT. Review focuses on stormwater management issues, particularly increased runoff volumes and pollutant loads to be generated by development and whether the proposed stormwater management proposal would adequately address the impacts of these two issues. Both the 2004 CT DEP Storm Water Quality Manual and the Branford Inland Wetland Regulations were used to determine if the plans were in compliance with the applicable standards. The erosion control plan was evaluated for compliance with the CT DEP 2002 Guidelines for Soil Erosion & Sediment Control.

Commercial Site Plans

- **Cannondale Corporation Headquarters -** Bethel, Connecticut
- **Village Bank Headquarters** – Danbury, Connecticut
- **Newtown Hardware -** Newtown, Connecticut
- **Amicus Healthcare Living Centers –** Rocky Hill, Connecticut
- **Nathan Hale Office Building** – Fairfield, Connecticut
- **Ridgefield Recreation Center** – Ridgefield, Connecticut
- **Silver Spring Country Clubhouse & Pool house renovations -** Ridgefield, Connecticut
- **Tiger Hollow Athletic Complex at Ridgefield High School -** Ridgefield, Connecticut

On-site sewage disposal systems

- **Candle Hill Mobile Home Park** – Design Subsurface Sewage Disposal Systems for individual mobile home units. New Milford, Connecticut.
- **Hemlock Hills Camp Resort** – Expansion of campground, design of gravity sanitary sewer and design of subsurface sewage disposal system to handle 4,800 gpd. Litchfield, Connecticut.
- **Old Field Condominiums** – long term inspection & reporting on the condition of multiple subsurface sewage disposal systems serving 40 unit condominium complex with design flows in excess of 15,000 gpd. Southbury, Connecticut.
- **Thorncrest Farm** – Design of on-site sewage disposal system to handle wastewater from milking operation. Goshen, Connecticut.
- **Silver Spring Country Club** – Design of multiple subsurface sewage disposal systems for private country club with average daily flow of 7,000 gpd during peak usage season.
- **Richter Park Golf Course** – Design subsurface sewage disposal system to replace existing failed system for golf club house and year round restaurant with average daily flow of just under 5,000 gpd.
- **Redding Country Club** - Performed soil testing to design a repair to an existing wastewater management system that was experiencing periodic effluent discharges during high use on very marginal soil conditions. Utilized oversized grease tanks for kitchen waste and septic tanks to increase the clarity of the effluent which was discharged by force main to the subsurface sewage disposal system increase the long term functionality of the system. Discharge rate 4,900 gpd.

General Civil Engineering Projects

- **Montgomery Residence**, 10,000 sq.ft. residence with 2.5 acre pond, Redding, Connecticut.
- **Neils Different,** Design 1 acre pond, Ridgefield, Connecticut.
- **Anthony DeLuca**, Design 2 acre pond**,** Redding, Connecticut.
- **Barrett Cram**, Design 0.5 acre pond, Redding, Connecticut.
- **Jay & Eileen Walker Residence**, 27,000 sq.ft. residence, Ridgefield, Connecticut.

Athletic Facilities

- **Kingdome – East Fishkill, NY,** Prepared comprehensive site plan for the construction of an air-supported structure covering 7.96 acres of land area. Project also includes the design of 303 parking spaces, two full size artificial turf baseball fields and three 54-80 artificial turf baseball fields. Designed all site grading and stormwater management facilities to address water quality volume, channel protection volume as well as peak rate attenuation for the 1-yr, 2-yr, 10-yr, 25-yr, 50-yr and 100-yr rainfall events.
- **Tiger Hollow – Ridgefield High School – Phase I**, Design and site artificial turf competition field and track complex. Design access road to provide access to new building containing locker rooms, concessions, media room, and equipment storage areas. Design all utility connections and obtain local permits.
- **Tiger Hollow – Ridgefield High School – Phase II**, Prepare Conceptual Development plan for reconfiguration of existing athletic fields adjacent to the Tiger Hollow stadium.
- **Joel Barlow High School – Redding, CT**, Provide preliminary Master Plan on pro bono basis for reconfiguration and improvement of existing athletic fields at Joel Barlow in response to Falcon Pride stadium proposal. Plan was provided to Region 9 Board of Education for general discussion purposes.

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November 6, 2018

Ms. Leslie King, Esq.
Murtha Cullina
One Century Tower
265 Church Street
New Haven, Connecticut 06510

Re: Solar Farm – Grassy Hill Road
East Lyme, Connecticut

Dear Ms. King,

Statement of Purpose:

You asked me to opine on the adequacy of the design and construction of the stormwater management system and erosion control elements of the solar farm on Grassy Hill Road in East Lyme, Connecticut. You also asked me to opine on whether those elements contributed to damage on the neighboring property of John Bialowans.

To reach my opinion associated with the solar farm constructed on Grassy Hill Road in East Lyme, I have reviewed the following:

1. Site inspection on October 5, 2018 of the completed solar farm on Grassy Hill Road and the streams on the Bialowans property.
2. Site plans prepared for Antares Solar Field by BL Companies, dated: October 9, 2012 and revised to July 16, 2013 as on file at the Connecticut Siting Council.
3. Stormwater Management Report prepared for Antares Solar Field by BL Companies, ("BL") dated: October 9, 2012 as on file at the Connecticut Siting Council.
4. Show Cause Hearing before East Lyme Wetlands Agency on May 5, 2014 on Cease and Desist Order Entered 6/10/2014 Report by Environmental Planning Services of April 30, 2014 regarding breach of erosion control/stormwater management measures.
5. Findings of Fact for Petition #1056 – GRE 314 East Lyme, CT by the Connecticut Siting Council, dated: May 16, 2013.
6. Four photographs of breach of erosion control/stormwater management measures (not dated) taken by others.
7. Photographs taken on 10/5/18 of the area of the solar farm, and stormwater management system as well as the streams on the John Bialowans property by my office.

Executive Summary of Opinions:

1. In the stormwater management report, BL grossly underestimated both the peak rate and runoff volumes generated by the project as they mistakenly consider the solar panels to be pervious. The panels are situated above the ground surface, thus every raindrop which falls on a panel instantly becomes runoff. They are impervious.
2. The developer and BL's design did not account for changes in soil compaction and porosity which resulted from the considerable regrading of the solar farm. The substantial cuts and fills of the solar farm resulted in a soil surface that has no infiltrative capacity, which will generate significantly more runoff than the undisturbed pre-development conditions.
3. The detention basin and leaky berm designed by BL are inadequately designed to attenuate the increases in runoff volume and peak rates of runoff. Because the design of the stormwater management practices inadequately addressed the actual amounts of runoff generated by the solar farm, the detention basins have not functioned as designed.
4. It is my professional opinion that BL's design of the erosion control plan was negligent, and certainly inadequate for its intended purpose. That design resulted in the failure of the erosion control measures during the construction period, resulting in the discharge of substantial amounts of sediments to the downgradient wetland and watercourses. The sediments smothered portions of the existing wetland system, resulting in a loss of natural functions of the wetlands.
5. It is my professional opinion that the design of the stormwater management system was negligent and inadequate and resulted in the discharge of higher volumes of runoff to the downgradient streams, resulting in the erosion of the channel banks and deposition of the eroded material.
6. The Solar farm was not designed in compliance with the specifications and approaches found in the State of Minnesota Stormwater Manual for solar farms as adopted by the CT DEEP. This is very important as the Minnesota Stormwater Manual sets forth very specific requirements for solar farms where the solar panels (which are solid impervious panels) can be considered pervious for the design of a stormwater management practice. These specifications and approaches in the Minnesota Stormwater Manual were not followed for the solar farm on Grassy Hill Road in East Lyme.
7. BLdid not design stormwater management and erosion control systems within the appropriate standard of care.
8. These inadequately designed and constructed stormwater management and erosion control systems caused substantial damage to the streams on the adjacent property owned by John Bialowans.

To support the above opinions, I have the following comments:

Developers Stormwater Management Plan and Report:

1. The developer did not consider the solar panels to be impervious. This was a substantial error in the developer's stormwater management analysis. While the solar panels are not actually on the ground surface, they do block the rainfall from reaching ground, thus each

drop of rainfall effectively becomes a drop of runoff. This runoff then falls onto the regraded, compacted soil surface and flows downhill. There was and will continue to be virtually no infiltration of runoff on this solar farm.

2. When soils are cut, filled, or have the surface regraded as was proposed here, the soil classification for use in the Hydrologic Model will change by at least one group designation. In this case, the Class C soils (pre-development) would become Class D soils and for a given ground cover would have a higher Runoff Curve Number (RCN). Therefore, both the peak rate and runoff volumes were and continued to be higher prior to the construction of the solar farm.
3. This error of using the wrong RCN has resulted in greatly underestimating the post development peak runoff rates and volumes for all storm events. Because the rates and runoff volumes are significantly higher than those calculated by the applicant, the design of the stormwater basins is also incorrect and are undersized.
4. The developer did not account for the Class D soils within the wetland area within drainage area A. Class D Soils will generate more runoff than a Class C Soil.
5. The time of concentration (Tc) flow path for both area A and B is not perpendicular to the contours in multiple locations. This Tc shortened when the peak rate of runoff occurs.
6. The shallow concentrated portion of the Tc for Drainage Area A is using what appears to be an average slope and does not account for steeper portions of the flow path which would result in a faster Tc and thus a higher peak rate of runoff.
7. The shallow concentrated flow portion of the Tc for Drainage Area B is using what appears to be an average slope and does not account for the steeper portions of the flow path which would result in a faster Tc and thus a higher peak rate of runoff.
8. In Drainage Area B, the developer stated that the Shallow Concentrated Flow path extends for over 1,600 feet along the edge of Walnut Hill Road, yet it does not appear that Walnut Hill Road is a through road based upon the watershed map and the flow path is not perpendicular to contours. As noted above, these assumptions made by the developer affected when and how much the peak rate of runoff is.
9. There was no investigation of on-site soil conditions to verify NRCS soil mapping.
10. Drainage Area A-1, A-2, A-3, A-4 and A-5 under post-development conditions are significantly regraded. Cuts up to 6' were made and fills up to 6' were made and yet the applicant claims in the stormwater report that the pre-development soil conditions will be applicable to post-development conditions. This is completely incorrect. When soils are cut and filled as was proposed here, the natural soil properties, particularly the ability of the regraded soil to infiltrate runoff and allow vegetation to become established are eliminated or significantly reduced. The regrading of the natural soils on the solar farm when combined with soil compaction, provided a soil base on which to install the solar panels which resulted in no infiltration of rainfall and increased rates and volumes of runoff being discharged from the solar farm for all rainfall events.
11. Drainage Area B-1 under post-development conditions is significantly regraded. Fills up to 10' were made and yet the applicant claims in the stormwater report that the pre-development soil conditions will be applicable to post-development conditions. This is completely incorrect. When soils are cut and filled as was done here, the natural soil properties, particularly the ability of the regraded soil to infiltrate runoff and allow vegetation to become established are eliminated or significantly reduced. The regrading

of the natural soils on the solar farm when combined with soil compaction, which provided a soil base to install the solar panels, resulted in surface condition with no capacity for the infiltration of rainfall and increased rates and volumes of runoff being discharged from the solar farm during all rainfall events.

12. The regraded slopes are uniform in pitch and have eliminated the natural depressions of the undisturbed slopes which would have allowed some of amount of rainfall to be trapped in the depressions and then infiltrated into the soils.
13. The long, uniform slopes also resulted in increased slope length of the soil surface. A key methodology for controlling runoff is to minimize the slope length under post-development conditions which prevents the runoff from becoming concentrated flow. Rainfall falling on these uniform services did not infiltrate, and instead it runs down the slope. As the rainfall runs down the slope, it becomes more concentrated in terms of runoff rate and volume, thus flow velocities increase. As the volume of runoff and flow velocities has increased, the erosive capacity of the runoff has also significantly increased sheet, rill and gully erosion on the slope. Once rill and gully erosion has occurred the initial time, the condition will worsen with each rainfall event. The condition on this site is continuing to worsen.
14. The CT DEEP has adopted standards and approaches developed by the State of Minnesota which are applicable to the development solar farms. The standards and approaches are found in the following link to the Minnesota Stormwater Manual:(https://stormwater.pca.state.mn.us/index.php?title=Stormwater_management_for_solar_projects_and_determining_compliance_with_the_NPDES_construction_stormwater_permit).
    a. The Minnesota Manual states the following *"Rain falls on a solar panel, which is impervious. The rain runs across the panel to the dripline, where it falls to the underlying surface. This water can infiltrate or run off downslope to the next panel. Considering the schematic to the right, runoff water passing across a length of (Y+Z) can infiltrate. Y is the downslope length from the dripline to the beginning of the next panel. The surface under Y is pervious with well maintained vegetation and receives direct rainfall in addition to runoff from the upslope panel. Water that runs across the land surface from one dripline to to the next dripline that does not infiltrate is considered to be the runoff."* However, there are several caveats to the above statement and these caveats are found in a subsection entitled "Assumptions and guidance" in the Minnesota Manual and are discussed in point below.
    b. The applicant misapplied the document entitled "Stormwater management for solar projects and determining compliance with the NPDES construction stormwater permit" which is part of the State of Minnesota Stormwater Manual.
    c. The Minnesota stormwater manual states that large scale solar farms can be considered "pervious" under certain conditions. These conditions are as follows:
        - The rows of solar panels must be set a minimum distance apart which in this case is 14.5'.
        - Runoff from the drip edge of one row of panels must fall on the ground and drain in a perpendicular direction toward the next downgradient row of panels.

- Projects must minimize site disturbance and grading activities where natural vegetation cover is preserved and/or restored.
- A "meadow" condition is preferable, particularly for slopes between 5 and 10 percent.
- Mowed areas, where approvable, should be kept to 4" minimum height.

These conditions were not met for the solar farm proposed in East Lyme. Specifically, a review of the grading plan showing the proposed solar panels show that runoff will flow parallel to the row of panels within the vegetated strip and not perpendicular for virtually the entire project area of 30 acres. The condition specified in the Minnesota Stormwater Manual that solar panels are pervious, which assumes a runoff flow perpendicular to the row of panels, is not applicable in this case. The soil surface was disturbed by the removal of stumps and organic debris and/or other regrading. Therefore, the condition specified in the Minnesota Stormwater Manual that "projects must minimize earth disturbance and grading activities…" is also therefore not applicable in this case. Lastly, many of the panels are located on slopes greater than 5.0% and the vegetation under and between the panels is to be lawn and not "meadow", so item 'e' above is not met.

d. Based solely on condition specified in the Minnesota Stormwater Manual the claim of the entire solar farm being pervious is erroneous. There is clear evidence in the field that concentrated runoff is flowing along the length of the vegetative strip and not perpendicular.
e. The entire 30 acre slated for the solar farm was clear cut, stumped and graded in several areas by substantial amounts, so the application is not minimizing site disturbance and grading activities.
f. Additionally, "meadow" is a natural condition, where it is only mowed for hay once a year and not lawn which is the ground cover in East Lyme.

Erosion and Sediment Control Plan:

1. The regraded slope on the west side of A-3 is over 15' in height and does not have reverse benches as required by the CT DEP 2002 Guidelines for soil erosion and sediment control.
2. The regraded slope on the west side of B-1 is over 15' in height and does not have reverse benches as required by the CT DEP 2002 Guidelines for soil erosion and sediment control.
3. Page GN-1 – grading and utility notes: Note #5 states that soils to be compacted in 8" maximum lifts under all building areas to 95% maximum dry density by ASTM D1557 (modified proctor test) or as directed by geotechnical engineer. By compacting the soils to this degree will make them structurally sound to build on, but also eliminates the ability of the soil to infiltrate any amount of rainfall, thus substantially increasing the amount of rainfall which becomes runoff even from a grass surface.
4. Based upon a literature review, the "leaky berm" proposed by the applicant does not conform to industry practice. The applicant proposes that the "leaky berm" will have a layer of crushed stone underneath of covering of topsoil with a layer of filter fabric separating the two materials. The idea is that runoff from an upgradient area will enter

the swale just above the "leaky berm" and slowly seep through the berm. Based upon the literature review, a "leaky berm" should commonly consists of several layers of gravel on top of each other with the finer gravel being on the bottom and larger gravel above to allow the flow rate to be higher. This system is commonly used to maintain a water surface in a pond or wetland and they allow overflows to occur in a dispersed fashion over a wide area. In this case, if the gravel layer of the "leaky berm" was clogged by sediment, flows within the upgradient swale would be directed to one or more of 4" PVC pipe installed through the berm. This would result in concentrated runoff being discharged instead of overland flow. In my professional opinion, the "leaky berm" by the applicant is not a proper runoff control method for this solar farm as the runoff directed to it is substantially higher than anticipated by the applicant. It was also not designed in accordance with industry standards for this type of stormwater practice.

5. The applicant proposed to cover certain steep slopes with North American Green product P300 permanent turf reinforcement mat. The detail on the plans show the mat to be installed perpendicular to the slope. Based upon pictures of the failure of the erosion/stormwater control measures, the actual fabric was installed parallel to the slope. This is simply wrong as installation parallel to the slope allows runoff to get under the mat surface and cause erosion of the underlying soils. It does allow not appear in the photographs that mat was properly stapled to the ground surface. (See Figure 1).
6. In several locations on the proposed plans, the perimeter control measures, silt soxx was installed perpendicular to contours which would cause concentrated flow to occur along the silt soxx and potentially overtop a down gradient erosion control installed parallel to the contours.
7. On Sheet EC-5 of the plan set, the silt soxx starts and stops on either side of outlet from a stormwater basin and/or spillway, so there is no erosion control measure directly downstream of outlet pipes for all detention basins or other outlets. This would any erosion of the berm uphill of the outlet pipes to be directly discharged to downgradient wetlands and watercourses.
8. Based upon photographs of the failure of the erosion/stormwater management controls, the soil in the berm was not compacted per the requirements on the plan and thus was highly susceptible to saturation and failure. If the soil in the berm was properly placed and compacted, it is unlikely that the berm would have failed as shown in Figure 2 and Figure 3.

Figure 1 - Erosion Control Blanket (mat)

Figure 2 - Failure of Stormwater Basin Berm

Figure 3 - Failure of Stormwater Basin Berm

Site inspection of Solar Farm and the streams Bialowans Property on 10/5/18:

1. The area under and between the soil panel arrays are maintained as mowed grass. This condition will generate more runoff than a "meadow" condition as specified in the Minnesota Stormwater Manual. (Figure 4).
2. The grassed areas between the rows of solar panels all pitch parallel to the panel rows which allows runoff to become concentrated flow. (Figure 4).
3. The operator of the solar farm must have experienced this concentrated flow as there are stone berms located at the downhill end of each grass row prior to the stormwater basins which were not on the approved plans. The only purpose for these stone berms is to slow the velocity of the runoff down. (Figure 5).
4. There is clearly no infiltration occurring within the grass areas between the solar panel rows as concentrated flow and rill erosion was observed. (Figure 6, Figure 7).
5. Erosion of the slope on the uphill side of at least two stormwater basins was observed, this is further evidence of concentrated runoff being generated by the solar farm. (Figure 8).
6. All the stormwater basins have been lined with modified riprap which was not specified on the approved plans.
7. Facultative wetland plants have become established in the bottom of most, if not all the stormwater basins which are clear evidence that no infiltration is occurring in these basins as represented in the stormwater management report for this project. (Figure 9).

Figure 4 - Grass under and between solar panels

Figure 5 - Stone Berms at downhill end of panel rows

Figure 6 - Concentrated flow from runoff off solar panel

Figure 7 - Erosion & Sedimentation resulting from concentrated flow

Figure 8 - Erosion of stormwater basin slope from concentrated runoff

Figure 9 - Wetland Conditions in Bottom of Stormwater Basin

Findings of Fact by the Connecticut Siting Council of May 16, 2013:

Condition #68 of the Findings of Fact states "No wetlands or watercourses would be directly affected by construction of the solar field." This condition was violated by the developer in the following manner. During the active construction period a significant discharge of sediment was discharged from the solar farm (Environmental Planning Services report of

April 30, 2014) and into the downgradient wetlands and watercourses resulting the deposition of sediment in wetlands and watercourses. The discharge of sediment was the direct result of the inadequacy of the erosion and sediment control plans prepared for this project.

The un-named stream on the Bialowans property is experiencing erosion of the channel banks after the development and stabilization of the solar farm due to the discharge of increased runoff volumes from the solar farm. The increased runoff volumes being discharged are a direct result of the invalid assumptions made in the stormwater management report and plan.

Condition #89 of the Findings of Fact states "No increase of run-off is anticipated from the solar panels. A crushed stone drip line would be installed beneath the edge of each solar panel to facilitate water percolation into the soil. Well-drained soils are within the soil field, further enhancing percolation." This condition has been violated in the field by the developer as the stone drip line was not installed in the field. Additionally, because of the assumptions made in the stormwater management report, significant increases of runoff volume are being discharged from the solar farm and adversely affecting the un-named watercourse on the Bialowans property.

Stream Impacts on Bialowans' Property:

I have also inspected the unnamed stream and Cranberry Meadow Brook on the Bialowans' property. There is clear evidence that increased runoff volumes from the solar farm is adversely affecting the channel of the unnamed stream. Figure 10 shows one spot of several in the unnamed brook where the channel bank is being undercut by increased runoff volumes and flow duration from the stormwater basins on the solar farm property. In other words, the stream channel is physically reacting to the increased volume and flow duration of runoff from the solar farm, with the erosion widening the channel width to accommodate the higher flows. Figure 11 shows additional channel bank undercutting in the unnamed stream. Figure 12 shows the deposition of eroded material from the un-named stream at the confluence with Cranbury Brook. Lastly, Figure 13 shows the adverse impact of increased runoff volumes and flow duration from the stormwater basins on the solar farm property. Figure 13 shows erosion of the channel banks at the rear of the photograph as a result of the increased flow duration of the runoff from the solar farm. Additionally, the increased runoff volumes have higher flow velocities and this has resulted in the flow being able to move large branches down the channel and then deposit them in the channel when the flow velocities slow down. Lastly, the large sediment deposit in the foreground of the photograph is the material which has been eroded from the channel banks by the increased runoff volumes and flow duration.

Figure 10 - Undercutting of channel bank of un-named stream on Bialowans Property

Figure 11 - Erosion and sedimentation in un-named stream on Bialowans Property

Figure 12 - Eroded material deposited adjacent to Cranberry Meadow Brook on Bialowans Property

Figure 13 - Eroded material and debris from un-named stream near confluence with Cranberry Meadow Brook on Bialowans Property

My CV is attached to this report. Please feel free to contact my office if you have any questions concerning the information found in this report.

Respectfully Submitted,

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Qualifications	B.S. / Forest Management/1980 University of New Hampshire
Licenses/Certifications	Licensed Professional Engineer- Connecticut (1988) Licensed Professional Engineer – Maryland (2017)
Professional Societies	American Society of Civil Engineers National Society of Professional Engineers Connecticut Society of Professional Engineers Soil and Water Conservation Society of America International Erosion Control Association American Society of Agricultural and Biological Engineers
Professional Awards	Steve was named an Industry Icon by Storm Water Solutions in July 2015 http://editiondigital.net/publication/?i=263831&p=16 for his work in the Low Impact Development field.

International Experience

South Korea – July 2017, June 2016, April 2015, October 2014, April 2014, October 2013 and June 2013

- Steve was invited by Dr. Leeyoung Kim of Kongju University to make a presentation at the Seoul International Symposium for water cycle held on July 27, 2017 at Seoul City Hall. Steve's presentation was entitled "Sustainable Urban Water Cycle Management, Low Impact Development Strategies for Urban Retrofits". Steve also made a presentation to Master and PhD Engineering students at Kongju University on designing LID treatment systems. He also visited the research office of Land & Housing Institute in Daejeon to inspect recent LID retrofits consisting of Bioretention systems, Bioswales and Permeable Paver systems.
- Steve was invited by Dr. Shin to visit the Korean GI/LID research center in July of 2017. The purpose of the visit was to inspect the LID research systems which had been in place for a year to observe how well they were functioning and also to observe the current research on infiltration of LID systems and evaportranspiration of green roof systems.
- Steve was an invited attendee to the official opening of the Korean GI & LID Research Center recently constructed at the Yangsam Campus of Pusan National University. Steve was a consultant on the design of the research center for Dr. Hyunsuk Shin of Pusan National University.

- Steve was an invited presenter at the World Water Forum by Dr. Hyunsuk Shin of Pusan National University. He presented case studies of GI/LID applications in the United States.
- Steve was invited by Dr. Yong Deok Cho of Kwater to participate in the Water Business Forum at the World Water Forum. Steve presented an overview of his business and expertise in Low Impact Development.
- Steve was invited by Dr. Hong-Ro Lee of Kunsan National University and made a presentation entitled "Understanding Low Impact Development in the Urban-Rural Interface" for the **Ariul Brainstorming Working Group** on April 16, 2015 in Gunsan, South Korea. He also toured portions of the proposed land reclamation area to assess how Low Impact Development strategies could be incorporated to address water quality issues from the proposed agricultural, residential, commercial and industrial land uses for this area.
- Steve was a Contributing Author as well as an Advisory Reviewer for a report prepared by Land & Housing Institute (LHI) entitled " Pyeongtaek Godeok New City Low Impact Development techniques (LID), A study on the introduction of measures (I) " dated: January 2015. This report by LHI also cited the Town of Tolland LID Design Manual as a foreign LID Manual to be used as a reference document.
- Steve was an invited presenter at the International Water Forum 2014 held in conjunction with the Nakong River International Water Week in Gyeongju, South Korea sponsored by DaeGyeong Water Foundation & the International Hydrologic Environmental Society. His presentation focused on urban stormwater and the benefits of LID in these areas.
- Steve was an invited presenter at the IWA Water Reuse & Energy Conference 2014 held in Daegu, South Korea. His presentation was on the regulatory barriers to implementation of LID and how to overcome these barriers. He also participated in a panel discussion with other presenters.
- He also made a presentation at The 1st GI & LID Technical Education Workshop held at Pusan National University on October 22nd on an overview of LID and the application of LID concepts. He was invited by Dr. Kyung Hak Hyun of Land & Housing Institute (LHI) to make two presentations of LID case studies at Sangyung University and at a seminar hosted at LHI along with Kwater.
- Steve met with Jong-Pyo Park, Director and Kyoung-Do Lee, CEO of HECOREA, a water resource consulting firm to discuss LID in dense urban areas. Steve signed a MOU with HECOREA to provide consulting services on LID monitoring approaches and maintenance protocols for the Go-Deok International Planning District near Pyeongtaek, South Korea.
- Steve was invited by Dr. Kyung Hak Hyun of Land & Housing Institute to present at the 2nd Low Impact Development Forum in Daejeon, South Korea on October 31, 2013. He also inspected the site of Asan-tangjeong which is an expansion of residential housing for the city of Asan. This expansion will incorporate LID stormwater strategies.
- Steve was invited to make a presentation of the implementation of LID on commercial sites by Dr. Reeho Kim of the Korea Institute of Construction Technology in Seoul.
- Steve met with Dr. Sangjin Lee of Korean Water and Dr. Woo Young Heo, CEO of LID Solution Co, Ltd to review the initial concept plans for the Eco-Delta City project. Eco-Delta City is a new city located near the Gimhae International Airport of 13 square kilometers and will incorporate LID concepts throughout the new city.

- Steve signed a MOU with Dr. Shin of Pusan National University to provide consulting services for the Smart GI/LID Research Facility at Pusan National University. Steve was asked by Dr. Shin to review the design plans for the GI/LID research facility to be constructed at Pusan National University with a focus on the exterior LID research facilities. He provided a written comprehensive review for consideration by PNU.
- Steve was invited by Dr. Hyunsuk Shin of Pusan National University in South Korea to present a workshop on Low Impact Development on June 24, 2013. The presentation was made to research professors, graduate engineering students and practicing engineers at K-water headquarters in Daejeon, South Korea. He also met with representatives of other agencies tasked with the development of a new city, called Eco-Delta City which will implement LID practices from the ground up and comprises approximately 3,500 acres.

Nanjing, China, September 2018
Steve was invited by the organizing committee for the third China Sponge City International Exchange Conference to make three presentations on LID. The presentations were entitled: "LID: The Good, the Bad and the Ugly", "Permeable Pavement Case Studies" and "The regulatory framework to adopt LID". The conference was held September 27th and 28th in Nanjing, China.

Beijing/Zhenjiang, China – August 2017
Steve was invited to make a presentation entitled "Urban LID in China and South Korea" at the 2017 Second China Sponge City International Exchange Conference held in Beijing on August 16-1, 2017. He also made a presentation for Dr. Nian She, Director of Smart Sponge City Planning and Construction Research Institute in Zhenjiang, China on modeling approaches for LID treatment systems as well as inspecting some recent LID retrofits currently under construction in Zhenjiang.
Steve also made a presentation at Reschand entitled "LID Case Studies from US" at the request of Yuming Su of Reschand.

Nanjing, China – September 2016
Steve was invited to present at the 2016 First China Sponge City International Exchange Conference held in Nanjing, China. The presentation focused on several case studies of LID systems in the US.

Zhenjiang, China – June 2015
Was retained by Dr. Nian She to design Urban LID retrofits for a 2.5 hectare (6.5 acres) dense residential area in the city of Zhenjiang. The LID retrofits had to fully treat runoff from the existing impervious areas (building roofs, driveways and parking areas) for 65 mm (2.6") of rainfall in 24 hours. The LID systems also had to attenuate the peak rate of runoff for a rainfall event of 150 mm (5.9") rainfall event. A combination of Bioretention systems, and permeable pavers with a filter course and reservoir layer were used to meet these stormwater requirements.

Zhenjiang, China – May 2015
Steve was invited by Professor Nian She of Shenzhen University to make a presentation entitled "Using LID to Attenuate Large Rainfall Events and Reduce Flood Potential" at the 2015 First

Sino US Sponge City LID Technology Practice Conference held on May 4-5, 2015 in Zhenjiang, China organized by Zhenjiang Water Supply and Drainage Management Office. (http://www.c-water.com.cn/2015lid/en/index_e.html). In addition to the presentation, field inspections were made of several new LID installations in the city consisting of Bioswales, permeable pavement systems and rainwater harvesting.

Guangzhou, China – December 2012

- Steve was an invited attendee at the 15th Annual Guangzhou Convention of Chinese Scholars in Science and Technology in Guangzhou, China on December 17 – 21, 2012 to present a project narrative on how Low Impact Development and sustainable development can be applied to address water quality issues in urban and rural areas of China to implement sustainability concepts and conservation of resources. He attended with Dr. Jim Su, PE of Golder Associates of Mt. Laurel, New Jersey. While at the convention he met with representatives from Sichuan University, Chang'an University, Guangdong University of Technology, Shenzhen University and the South China Institute of Environmental Sciences, MEP to discuss LID being incorporated into their engineering programs.
- Steve also met Dr. Hongbin Cheng of New China Times Technology which is located in Stellenbosch, South Africa. Steve has signed a three-year partnership agreement with New China Times Technology to introduce LID concepts to the west cape area of South Africa.

Taiwan – December 2011

- Steve was invited by Hung Kwai Chen, Director of the Water Resources Planning Institute, Water Resource Agency, Ministry of Economic Affairs of Taiwan and Dr. Yong Lai of the US Bureau of Reclamation to present a 12-hour presentation on Low Impact Development on December 8th and 9th, 2011 in Taichung, Taiwan. The presentation focused on applying LID strategies in both urban and rural environments to address runoff volumes and water quality issues.
- Steve is an invited consultant to a project team headed up by Xiaoyan Zhou, PhD of the Institute for Taiwan Water Environment Research (TIIWE) along with The National Taiwan Ocean University, Hohai Engineering Professor Liao Chaoxuan, Ting Engineering Consultants Co., Ltd and University of Colorado professor Guo Chunyuan to develop a LID demonstration project in New Taipei City along with LID policy strategies to further the use of LID in New Taipei City, Taiwan.

Low Impact Development

- Review of existing municipal land use regulations to identify barriers to the implementation of Low Impact Development
- Preparation of regulatory language changes to facilitate the adoption of Low Impact Development
- Preparation of design manuals for the implementation of Low Impact Development strategies and processes with an approach that simplifies the design process

- Application of environmental site design strategies to focus development concepts on land most suitable for development while enhancing the protection of environmentally sensitive areas

- Design of Low Impact Development treatment systems, such as Bioretention areas, wet/dry swales, vegetated level spreaders, vegetated filter strips, subsurface gravel wetlands, constructed wetlands and/or pond systems, infiltration basins & trenches

- Hydrologic analyses of current and post-development conditions to assess impacts of proposed development on storm water flows

- Design of storm water control systems including detention and water quality basins and appropriate planting plans

- Perform hydrologic modeling of stormwater management systems to demonstrate compliance with regulatory benchmarks

- Prepare Pollutant loadings analyses to evaluate the effectiveness of stormwater treatment designs in reducing pollutant loads

Wastewater Management:

- Soil testing to determine suitability of land to support on-site sewage disposal systems for residential and commercial projects and assistance with identifying optimal location for both small and large scale system

- Perform necessary calculations to model and design large scale subsurface sewage disposal systems under CT DEEP criteria and State Department of Public Health

- Design of on-site sewage disposal systems in accordance with state and local health codes

- Perform construction oversight of both small and large scale subsurface sewage disposal systems and provide certifications of compliance

Site Engineering:

- Development feasibility studies

- Layout concepts to maximize development, while preserving environmentally sensitive areas

- Design of horizontal and vertical road geometry

- Preparation of grading, drainage and erosion and sedimentation control plans

- Use AutoCAD Land Development, Civil3D, HydroCAD and Pondpack software packages

- Layout and design of sanitary sewers

- Bid estimates

- Construction oversight
- Third party technical reviews
- Expert testimony

Professional Committees

- Chairman and primary author of EWRI/ASCE LID Model Ordinance Task Committee (goal is to create a National LID Guidance document to further the adoption of LID)
- Chairman of EWRI/ASCE LID Task Committee on Filter Strips and Bioswales (goal is to review & evaluate literature and design specifications for filter strips and Bioswales and create uniform design standards for different geographical regions)
- Member of EWRI/ASCE LID National Guidelines Task Committee
- Connecticut Representative to the Board of Directors of the Northeast Chapter of the International Erosion Control Association

Published Articles

- **"Easier Said Than Done – Overcoming common errors when installing bioretention systems"** – October 2018 edition of Storm Water Solutions by Scranton Gillette Communications.
- **"Large-scale LID Design for urban expansion in South Korea**" with co-author, Dr. Kyung Hak Hyun of South Korean Land and Housing Institute – Volume 3/Issue 4, August/September 2015 – Worldwater Stormwater Management by the Water Environmental Federation.
- "**Research team leads LID deployment in South Korea**" – Volume 2/Issue 1, Spring 2014 – Worldwater Stormwater Management by the Water Environmental Federation.
- "**Low Impact Development, Sustainable Stormwater Management**" – English article converted to Chinese and published in the Chinese Edition of Global Water Magazine, July 2013.
- "**A Case Study: Southbury Medical Facility and Low Impact Development**" - January/February 2014 issue of Land and Water.
- "**A True Pioneer of Low Impact Development – Member Spotlight**" – January/February 2014 Issue of Erosion Control – Official Journal of the International Erosion Control Association.
- "**Low Impact Development: Changing the Paradigm**" published in the March 2012 edition of PE, The Magazine for Professional Engineers by the National Society of Professional Engineers. Article was also republished in the Spring 2012 addition of EWRI Currents (with permission of NSPE).
- "**Stormwater Retrofit of Existing Detention Basins**" published in the March/April 2012 Land and Water, The Magazine of Natural Resource Management and Restoration with co-author Sean Hayden of the Northwest Conservation District.
- "**Out in the Open; Creating a Stormwater Park in the Heart of a Community**" published in the April 2013 issue of WaterWorld by Pennwell Corporation.
- "**Creating a Stormwater Park in the City Meadow of Norfolk, Connecticut**" published in the July/August 2013 edition of Land and Water

Volunteer Organizations

- President (elected 11/2013) and Connecticut Representative to the Board of Directors for the Northeast Chapter of IECA, (Chairman of 2012 Annual Conference to be held in Fishkill, NY)
- Chairman, Water Pollution Control Authority for the Town of Southbury

- Alternate member of Inland Wetlands Commission Town of Southbury (served three years)
- Northwest Conservation District Board of Directors (served 18 months)

Software Development

Developed a proprietary software application called **A**ssessment of **P**ollutant **L**oads and **E**valuation of **T**reatment **S**ystems (**A.P.L.E.T.S.**). This application calculates the pollutant loads for current and future land use conditions for the seven most common pollutants in non-point source runoff (TSS, TP, TN, Zn, Cu, TPH, & DIN) for a total of twenty two different types of land uses. The application then allows the evaluation of the effectiveness of thirty four Conventional and Low Impact Development treatment systems in removing these pollutants. Up to four treatment systems can be used in a row as a treatment train to achieve water quality goals.

Future Presentations

- Steve will be making two presentations at the 2019 Annual Conference of IECA being held in Denver, CO in February 2019. The presentations are entitled "A Study on Introduction Plan of Low Impact Development Techniques for Widespread Application in South Korea" and "If LID is so easy to implement, how come we keep getting it wrong". (https://www.eventscribe.com/2019/IECA/)

Invited Speaker Presentations:

- Steve made the following presentations at **St. Andrews University in Scotland** on October 19th for the Sustainable Development program. The first presentation is entitled "Improving the environment with Low Impact Sustainable Development Strategies". The second presentation is entitled "Addressing Water Quality and Runoff Issues in a changing weather world".
- Steve was invited by Dr. Jae Ryu of the University of Idaho Water Center to make a presentation entitled "Designing Low Impact Development treatment systems for **Urban & Agricultural Environments" at the Annual US-Korea Conference on Science, Technology, and Entrepreneurship** being held in Atlanta, Georgia on July 29 to August 1, 2015. (http://www.ukc.ksea.org/UKC2015/)
- Steve was invited by the Lake George Waterkeeper to make a presentation entitled "Applying LID Concepts in the Real World" at the 5th Annual Low Impact Development Conference being held in Lake George, NY on May 7, 2015. (http://fundforlakegeorge.org/2015LID)
- Steve was invited by Dr. Hyunsuk Shin and made a presentation entitled "Real Adaptation and Implementation of GI and LID Technology in USA" at the **World Water Forum** (http://eng.worldwaterforum7.org/main/) being held in Daegu, South Korea on April 14, 2015.

- Steve prepared a presentation for a workshop to civil and environmental engineering students at **Pusan National University** (http://www.pusan.ac.kr/uPNU_homepage/kr/default.asp) in Busan, South Korea on April 17, 2015 entitled "Designing LID System, What do you need to know and why".

- Steve was invited by Dr. Hong-Ro Lee of Kunsan National University and made a presentation entitled "Understanding Low Impact Development in the Urban-Rural Interface" for the **Ariul Brainstorming Working Group** on April 16, 2015 in Gunsan, South Korea. It will focus on how

Low Impact Development concepts can be applied to made land areas filled in off the west coast of South Korea to address water quality issues.

- Steve was an invited speaker at the **2014 Low Impact Development Conference** sponsored by the Lake George Waterkeeper and the Fund for Lake George in Lake George, NY on May 1, 2014 for land use professionals and regulatory agencies. He will be presenting case studies focusing on the application of LID concepts for commercial and residential projects.

- Steve was invited by Justin Kenney, Green Infrastructure Coordinator of the Vermont Department of Environmental Conservation Watershed Management Division to present an eight hour workshop entitled "From Bioretention to Permeable Pavement: An In-depth Introduction to Low Impact Development and Green Stormwater Infrastructure" in Montpelier, Vermont on December 5, 2013. The presentation was hosted by the **Vermont Green Infrastructure Initiative** with support from the following Vermont Agencies and Divisions; **Building and General Services, Ecosystem Restoration Program and Agency of Transportation.**

- Steve was invited to attend and present on the Application of LID Concepts for the Urban Environment and LID Case Studies at the 2nd Low Impact Development, Stormwater Management Forum hosted by the **Land & Housing Institute, Korean Land & Housing Corporation** to be held in South Korea in on October 31, 2013. He also made presentations at the **Korean Institute of Construction Technology** and **Pusan National University** on various aspects of LID during this time.

- Steve was an invited speaker at the **2013 Low Impact Development Conference** sponsored by the Lake George Waterkeeper and the The Fund for Lake George in Lake George, NY on May 2, 2013 for land use professionals and regulatory agencies. Over 80 design professionals and regulatory people were in attendance. He made a presentation entitled "Barriers to the implementation of LID".

- Steve was an invited presenter at a closed-meeting of the **National Association of Home Builders (NAHB) and the Water Environment Federation (WEF)** on October 10, 2012 focusing on progressive stormwater management. The presentation focused on the application of LID strategies on actual development projects and discussed the hydrologic performance and cost effectiveness of LID design.

- Steve was the invited presenter for a 1-hour long webinar presented by **Stormwater Solutions and Stormwater USA** on Low Impact Development and the Basics of Bioretention held on September 18, 2012. Over 760 individuals watched the webinar.

- Steve was an invited speaker at and **EPA/WEF Stormwater Technical Meeting** on July 18, 2012 in Baltimore, MD to discuss the application of Low Impact Development strategies for actual projects with a focus on cost effectiveness when compared to conventional stormwater management as well as field performance of the LID designs. The purpose of this meeting was to assist EPA in the development of a National Stormwater Rule.

- Site Design using Low Impact Development Strategies and What are the impacts of Impervious Cover on Water Quality and Quantity were presented at a workshop entitled "Challenges and Solutions using Low Impact Development", sponsored by the **Lake George Waterkeeper** in Lake George, NY on May 5, 2011 for land use professionals and regulatory agencies. 90 design professionals and regulators in attendance.

- Steve was an invited speaker at the **2012 Low Impact Development Seminar** sponsored by the Lake George Waterkeeper in Lake George, NY on April 25, 2012 for land use professionals and regulatory agencies. 100 design professionals and regulatory people were in attendance. He made a presentation entitled "The Hydrologic Benefits of Vegetation in Site Design".

Conference Presentations:

- Steve made a presentation entitled "LID in China and South Korea" at the 2018 Annual Conference of the Northeast Chapter of IECA in Concord, NH on October 1, 2018.
- Steve made a presentation entitled "If LID is so easy to implement, how come we keep getting in wrong" at the **2018 International Low Impact Development** conference being held in Nashville, TN on August 12 – 15, 2018. The conference is sponsored by ASCE and EWRI. (https://www.lidconference.org/)
- Steve made two presentations at the **2018 TRIECA Conference** being held on March 21 & 22, 2018 at the Pearson Convention Center in Brampton, Ontario. The presentations are entitled "Addressing Stormwater in China with Low Impact Development" and "Implement Low Impact Development in South Korea." This conference is sponsored by the Toronto and Region Conservation Authority and the Canadian Chapter of the International Erosion Control Association.
- Steve made the following presentations at the **2018 IECA Annual Conference** being held in Long Beach, CA in February of 2018. The presentations are entitled "How Low Impact Development strategies can mitigate high intensity rainfall events" and Designing Low Impact Sustainable Development treatment systems for Agricultural Environments".
- Steve was invited by the Dylan Drudul, President of the Mid-Atlantic Chapter of IECA to present the keynote address at a one day event called "Sediment Control Innovations Roadshow on July 14th in Columbia, Maryland. The keynote is entitled **"A Worldwide Perspective on Municipal Stormwater Issues".**
- Steve made a presentation entitled **"Designing LID Systems: What do you need to know and why"** at the 27th Annual Nonpoint Source Pollution Conference being held in Hartford, CT on April 20-21, 2016 as sponsored by the New England Interstate Water Pollution Control Commission.
- Steve will be presenting four one-hour long webinars through Halfmoon Seminars on Low Impact Development. The first entitled **"Introduction to Low Impact Development"** will be on May 10, 2016 at 12 pm. The second entitled **"Bioretention System Design"** will be offered on May 10, 2016 at 1:30 pm. The third entitled **"Applying LID Concepts to Residential Development"** will be offered on May 12, 2016 at 12 pm. The fourth entitled **"LID Case Studies"** will be offered on May 12, 2016 at 1:30 pm.
- Steve will be making a presentation entitled **"Designing LID Systems: What do you need to know and why**" at the UKC2016 conference, sponsored by KSEA (Korean-American Scientists and Engineers Association) at the Hyatt Regency DFW in Dallas, Texas, August 10 – 13, 2016.
- Steve made five presentations at the **2016 Environmental Connection** conference by IECA (www.ieca.org) being held in San Antonio, Texas on February 16 – 19, 2016. The presentations were entitled "Designing LID Systems: What do you need to know and why", "Construction Site Stormwater: The Ignored Problem", "Solving Construction Stormwater Problems in the Field", "Developing Effective LID Municipal Regulations", and "LID Demonstration Projects in Connecticut, a study of Contrasts".
- Steve made two presentations at the **EPA Region Stormwater Conference 2015** (http://epa.gov/region6/water/npdes/sw/ms4/2015conference/index.html) being held in Hot Springs, AR on October 18-23, 2015. The presentations are entitled "Designing LID systems: What do you need to know and why" and "Designing LID treatment systems for Urban and Agricultural Environments."

- Steve made a presentation entitled "Applying LID strategies to residential and commercial developments to address water quality and runoff volumes" at the KSEA Northwest Regional Conference 2015 held at the Idaho Water Center in Boise, Idaho on October 11, 2015.
- Steve made a presentation entitled "Solving Construction Stormwater Problems in the Field" at **WEFTEC 2015** (http://www.weftec.org) in Chicago, IL on September 29, 2015.
- Steve made three presentations entitled: "Korean GI/LID Research Facility", Applying LID concepts to High Density Residential Developments, and Municipal LID Regulations" at the 2015 Environmental Connection IECA Annual Conference being held in Portland, Oregon on February 16 – 18, 2015. He also presented a half day workshop entitled: "Designing LID Projects". He moderated an Expert Panel on Low Impact Development with Seth Brown, (Water Environment Federation), Bob Adair (Construction Ecoservices, Inc.) and Roger Sutherland (AMEC)

- Steve made two presentations at International Low Impact Development Conference 2015 in Houston, Texas which is sponsored by ASCE-EWRI. The presentations are entitled "Korean GI/LID Research Facility", and "LID Demonstration Projects in Connecticut: The Good and the Bad".

- Steve made presentations entitled "Overview of Low Impact Development" and "The Application of Low Impact Development Strategies for Land Development Projects" along with Dr. Jae Ryu of the University of Idaho and Dr. Hyun-Suk Shin of Pusan National University at the annual meeting of the **American Water Works Association** in Tyson Corners, VA on November 6, 2014.

- Steve made two presentations entitled "Construction Site Stormwater: The Ignored Problem" and "Applying LID Concepts to High Density Residential Development" at the **2014 Annual Conference and Trade Show of the Northeast Chapter of IECA** held at Lake Morey, Vermont on November 4 – 5, 2014.

- Steve made the following presentations entitled: "A Case Study – Southbury Medical Facility and Applying LID concepts on undeveloped land and in the urban environment" at Municipal Wet Weather Stormwater Conference, hosted by the **Southeast Chapter of IECA** in Charlotte, NC on August 18th and 19th, 2014.

- Steve made the following presentations: "The Incorporation of LID on Affordable Housing Projects, A Case Study – Southbury Medical Facility and LID' and Municipal LID Regulations" at the **16th Annual EPA Region 6 Stormwater Conference** sponsored by the South Central Chapter of IECA in Fort Worth, TX on July 27th through August 1st, 2014.

- Steve made oral presentations at the **2014 Environmental Connection** sponsored by the International Erosion Control Association in Nashville, Tennessee on February 25 – 18, 2014. The presentations were entitled "A Case Study – Southbury Medical Facility and LID", "The Implementation of the Highland Estates Detention Basin Retrofit water quality impairment in Northfield Lake", and "Creating Effective Municipal LID Regulations".

- Steve co-presented an all day workshop on Low Impact Development with Jamie Houle of the University of New Hampshire Stormwater Center at the **2013 International Erosion Control Association Northeast Chapter Conference and Trade Exposition** on November 19 – 21, 2013 in Warwick, RI.

- Steve made three oral presentations at the **2013 International Low Impact Development Symposium** held at the Saint Paul RiverCentre in Saint Paul, Minnesota on August 18 – 21, 2013. The presentations were entitled "A Case Study – Southbury Medical Facility and LID", "LID

regulations in Connecticut: The Long and Tortured Road", and "Creating a Stormwater Park in the City Meadow of Norfolk, Connecticut."

- Steve presented two papers at the **2013 EWRI World Environmental and Water Resources Congress** held in Cincinnati, Ohio on May 19- 23, 2013. The papers are entitled: "Municipal LID Regulations - What is important to include to be successful?" and "Creating a Stormwater Park in the City Meadow of Norfolk, Connecticut". http://content.asce.org/conferences/ewri2013/index.html

- Steve made a presentation at the **Soil and Water Conservation Society Winter Conference** held in Berlin, Connecticut on February 15, 2013. The presentation focused on erosion and sedimentation control issues with Low Impact Development treatment systems.

- Steve presented two papers at the **2013 Environmental Connection** held in San Diego, CA on February 10 – 13, 2013. The papers are entitled "LID Demonstration Project for Seaside Village in Bridgeport, Connecticut" and "Creating a Stormwater Park in the City Meadow of Norfolk, Connecticut". He also presented a full day LID workshop entitled "Next Generation Low Impact Development and Meet Today's Needs" and a half day workshop on Low Impact Development covering Environmental Site Design, Water Quality Issues, Pollutant Loading Analyses, Designing different types of LID treatment systems and actual case studies.

- Steve made three presentations at the **2012 Annual Conference of the Northeast Chapter of IECA** in Fishkill, NY on November 7, 8, & 9, 2012. The presentations are entitled: "LID Demonstration Projects in Connecticut, A Study of Contrasts, Environmental Site Design and LID Hydrologic Issues, and Siting and Designing LID Treatment Systems with Case Studies"

- Steve made two oral presentations entitled "Applying Environmental Site Design Strategies to Design a Residential Subdivision" and "The incorporation of LID on Affordable Housing Projects" at the **2012 Ohio Stormwater Conference** in Toledo, Ohio sponsored by the Ohio Stormwater Association on June 7th and 8th, 2012.

- Presented two papers at the **ASABE Watershed Technology Conference** in Bari, Italy, May 28 – 30, 2012. The papers were entitled "LID Demonstration Project for Seaside Village in Bridgeport, Connecticut" and "The creation of a Stormwater Park in the City Meadow of Norfolk, Connecticut".

- Steve made one oral presentation entitled "LID Demonstration Project for Seaside Village in Bridgeport, Connecticut" and presented one poster entitled "The Incorporation of LID on Affordable Housing Projects" at the **2012 World Environmental & Water Resources Congress** in Albuquerque, New Mexico sponsored by EWRI/ASCE on May 20 - 24, 2012.

- "Stormwater Retrofit of Highwood Estates Detention basins to address Water Quality Issues and How the application of Environmental Site Design Strategies can provide a resource for carbon sequestering" were presented at the **2011 International Erosion Control Associated Northeast Chapter Annual Conference** on December 1 – 3, 2011 at the Crowne Plaza Hotel in Natick, Massachusetts.

- Stormwater Retrofit of Highwood Estates Detention Basins to enhance Water Quality Benefits; A Low Impact Development (LID) Model Ordinance and Guidance Document and The Farmington River Enhancement Grants: A tale of three towns and the path to Low Impact Development were presented at the **Philadelphia Low Impact Development Symposium "Greening the Urban**

Environment" in Philadelphia, PA (September 2011) sponsored by EWRI, Villanova University, North Carolina University and the University of Maryland.

- Stormwater Retrofit of Highwood Estates Detention Basins to enhance Water Quality Benefits; The Farmington River Enhancement Grants: A tale of two towns and the path to Low Impact Development and A Low Impact Development (LID) Model Ordinance and Guidance Document was presented at the **EWRI/ASCE 2011 World Environmental & Water Resources Congress** in Palm Springs, CA (May 2011).

- Stormwater Retrofit of Highwood Estates Detention Basins to enhance Water Quality Benefits was presented at the "Annual Nonpoint Source Pollution Conference", sponsored by the **New England Interstate Pollution Control Commission** in Saratoga Springs, NY, on May 17-18, 2011.

- Stormwater Pollutant Load Modeling presented at the **Northeast Chapter of IECA Annual Conference** at the University of New Hampshire Stormwater Center in Durham, NH (December 2010).

- How the application of Environmental Site Design Strategies and Low Impact Development Storm Water Treatment Systems can mimic the Natural Hydrologic Conditions in a watershed and provide a resource for carbon sequestering and The Importance of Assessing Pollutant Loads from Land Development Project and the Design of Effective Storm Water Treatment Systems at the **EWRI/ASCE Watershed Management Conference** in Madison, WI (August 2010).

- The Tolland Low Impact Development Design Manual: The Changing Paradigm for Land Development, The application of Environmental Site Design Processes to design a residential subdivision and A Low Impact Development (LID) Model Ordinance and Guidance Document at the **ERWI/ASCE 2010 World Environmental and Water Resources Congress** in Providence, RI (May 2010).

- The application of Form-Based Zoning and Low Impact Development for the Revitalization of the Town Center of Simsbury, Connecticut and The Integration of Low Impact Development to enhance the application of Smart Code Zoning to create a Gateway District to the Historic Town Center of Tolland, Connecticut at the **EWRI/ASCE 2010 International Low Impact Development Conference** in San Francisco, CA (April 2010).

- The application of Environmental Site Design Processes to design a residential subdivision and Assessing Pollutant Loads and Evaluation of Treatment Systems to achieve Water Quality Goals for Land Development Projects at the **EWRI/ASCE 2009 World Environmental & Water Resources Congress** in Kansas City, Missouri (May 2009).

- Ahead of the Curve – Tolland, CT adopts Low Impact Development Regulations and Preparing a Pollutant Loading Analysis for Land Development Projects at the **Urban Water Management Conference** in Overland Park, KS sponsored by National Association of Clean Water Agencies (NACWA) and the City of Independence Water Pollution Control Department (March 2009).

- Ahead of the Curve – Tolland, Connecticut adopts Low Impact Development Regulations and Trade Winds Farm – Winchester, Connecticut – How to create a LID subdivision along with the preparation of a poster on Preparing a Pollutant Loading Analysis for Land Development Projects at **EWRI/ASCE 2008 International Low Impact Development Conference** in Seattle, WA (November, 2008).

- Trade Winds Farm – Winchester, Connecticut – How to create a LID subdivision and Preparing a Pollutant Loading Analysis for Land Development Projects at the **IECA Northeast Chapter's Annual Conference & Trade Exposition** in Portland, ME (October, 2008).

- The Preparation of a Valid Pollutant Loading Analysis at the **National StormCon 2008 Conference** in Orlando, FL (August, 2008).

- Panelist with Linda Farmer, AICP for Profiles of Partnerships for Addressing NPS Pollution at **NEIWPCC Annual Non-point Source Pollution Conference** in Groton, CT (May, 2008).

Workshop Presentations:

- Steve presented a webinar entitled "Construction Stormwater Regulation Strategies: Best Practices to Assure NPDES Compliance" on Thursday, November 12, 2015 at 2:00 pm to 3:00 pm eastern time. The webinar is sponsored by Business and Legal Resources (www.blr.com).
- Steven presented a full day workshop entitled "Stormwater Management 2015" in Columbia, Maryland on August 13, 2015 which focused on applying the State of Maryland Stormwater Manual. The workshop was sponsored by Halfmoon Seminars, LLC and 113 people attended the workshop.

- Steve presented a full day workshop on "Stormwater Regulations in Connecticut", sponsored by Halfmoon Seminars, LLC in North Haven, Connecticut on June 25, 2014. More than 30 engineers and landscape architects attended the workshop.

- Steve was the facilitator in a live chat as part of the Stormwater Solutions Virtual Trade Show on April 2, 2014. The topic of the live chat will be LID with a focusing on Bioretention systems.

- Steve made a presentation entitled "What is Low Impact Development and how do you apply it to residential projects" for the Connecticut Chapter of the American Institute of Architects in New Haven, Connecticut on April 22, 2014.

- Steve made a presentation entitled "Wastewater to Stormwater; Designing a subsurface flow gravel wetlands" at the annual meeting of the Connecticut Association of Wetland Scientists on March 20, 2014 in Southbury, Connecticut.

- Steve made a presentation entitled " Low Impact Development and the Connecticut General Stormwater Permit" at the annual meeting of the Southern New England Chapter of the Soil and Water Conservation Society on March 14, 2014 at Eastern Connecticut State University.

- He co-taught an ASCE Short Course entitled, "Introduction to Low Impact Development" with Mike Clar at the 2013 Low Impact Development Symposium held in St. Paul, Minnesota on August 18, 2013.

- Steve presented a workshop on Low Impact Development to the Town of Naugatuck Inland Wetlands Commission on June 5, 2013 to demonstrate how the implementation of LID can reduce stormwater impacts in the urban area of the community.

- Steve presented a webinar entitled "The Basics of Low Impact Development on Wednesday, April 17, 2013. More information is available at http://www.ieca.org/education/webinar/livewebinars.asp

- Steve presented a webinar entitled "Changing the Regulatory Framework to Adopt LID Strategies" on Thursday, March 7, 2013 and on Thursday, August 8, 2013 from 11:30 am to 1:00 pm through **ASCE and EWRI.** Link for more information: http://www.asce.org/Continuing-Education/Brochures/Webinars/ChangingRegulatoryFrameworkLIDStrategies/#Purpose

- Steve presented a three hour workshop on Low Impact Development on June 5, 2012 at the Oxford town hall for municipal land use staff and officials at the request of the **Oxford Inland Wetlands and Watercourses Commission**. Approximately 20 individuals attended the workshop.

- Steve presented an eight hour short courses on Low Impact Development at the **EWRI/ASCE 2011 World Environmental & Water Resources Congress** in Palm Springs, CA (May 2011). The following topics will be covered: Understanding and Implementing Principles of Low Impact Development, Applying LID Strategies to a Site, Low Impact Development Hydrologic Considerations, The Regulatory Framework and LID, LID Integrated Management Practices, Erosion and Sedimentation Controls for the Implementation of LID Practices and Case Studies (Applying LID and Regulations). 12 attendees took the course, including professors from Mississippi State University, Oklahoma State University, Adelaide University (Australia) and Pusan National University (South Korea).

- Understanding and Implementing Principles of Low Impact Development, Applying Low Impact Development to a Site, Low Impact Development Hydrologic Considerations, Low Impact Development Integrated Management Practices, Erosion and Sediment Control for the Implementation of Low Impact Development Practices, and Case Studies of LID (Residential and Commercial) at workshops on Low Impact Development sponsored by **HalfMoon, LLC** (https://www.halfmoonseminars.com) in Albany, NY, Ronkonkoma, NY, North Haven, CT, Manchester, NH, Nanuet, NY, Cleveland, OH, Natick, MA, Portland, ME Fort Washington, PA, Springfield, MA, Wilmington, DE, White River Junction, VT, Somerset, NJ, and White Plains, NY for continuing education credit for design professionals. A total of 322 land use professionals have attended these workshops.

- Pollutant Loads and the Design of Effective Stormwater Treatment Systems was presented at the Virtual H2O conference on February 22, 2011 as presented by **PennWell Publishing**. 25 professionals in attendance.

- LID Stormwater Treatment Systems: Siting, Design and Installation for Maximum Environmental Benefit. What are the aesthetic, financial and maintenance implications? presented at a seminar for the **AIA Connecticut, Committee on the Environment** in New Haven, CT (December 2010). 70 architects in attendance.

- Low Impact Development and the Environmental Site Design process to create sustainable sites at a seminar for the **AIA Connecticut, Committee on the Environment** in New Haven, CT (September 2010). 40 architects in attendance.

- Workshop entitled Using Environmental Site Design Strategies and LID stormwater systems for commercial development at the **Connecticut Conference on Natural Resources** at the University of Connecticut (March 2010). 10 design professionals and regulatory staff in attendance.

- Implementing Low Impact Development in Your Community for the **Connecticut Technology Transfer Center** in Glastonbury, CT (November, 2009). 40+ professionals in attendance.

- What towns can do to encourage LID at the "Low Impact Development Forum" presented by the **Housatonic Valley Association** in Shelton, CT. (October 2009). 12 professionals in attendance.

- Town of Tolland, CT; Low Impact Development Regulations and Design Manual at the **Community Builders Institute** for the workshop entitled: "Swift, Certain & Smart: Best Practices in Land Use" (May 2009). 30+ professionals in attendance.

- Low Impact Development, Environmental Site Design and Water Quality issues and strategies to local municipalities (**Greenwich, and Old Lyme**) to provide an educational opportunity about the many benefits of Low Impact Development in 2009. 30+ design professionals, regulatory commissioners and staff in attendance for each presentation.

- Low Impact Development, Environmental Site Design and Water Quality issues and strategies to local municipalities (**Bolton, Farmington, and Guilford** to date) on a pro bono basis to provide an educational opportunity about the many benefits of Low Impact Development in 2009. 25+ design professionals, regulatory staff and commission members in attendance for each presentation.

- Workshop entitled Using Environmental Site Design Strategies to create a residential subdivision at the **Connecticut Conference on Natural Resources** at the University of Connecticut (March 2009). 20 design professionals and regulatory staff in attendance.

- The Need for Pollutant Loading Analyses for Land Development Projects to storm water engineers at **CT DEP** (March 2009). 6 DEP staff in attendance.

- A review of existing land use regulations and storm water management issues for the Middle Quarter Districts in Woodbury, CT and how the implementation of Environmental Site Design and Low Impact Development strategies can improve water quality of storm water runoff for the Woodbury land use agencies (August 2008). 15 regulatory commission members in attendance.

- Low Impact Development at meeting of the **Connecticut Association of Zoning Enforcement Officers** (October 2007). 30+ professionals in attendance.

- Low Impact Development and adoption of LID regulations by municipalities at workshops of the **Land Use Leadership Alliance (LULA)** (2007, 2010 and 2011). 20+ professionals in attendance at each presentation.

- Stormwater management and Low Impact Development at workshop sponsored by the **Northwest Conservation District** held for land use officials (March 2006). 20+ professionals in attendance.

Conferences Attended

- Bioretention Summit: Ask the Researcher – Annapolis, MD by the University of Maryland (Dr. Alan Davis), North Carolina State University (Dr. Bill Hunt) and Villanova University Stormwater Partnership (Dr. Rob Traver) – (July 2010).

- Workshop at the University of New Hampshire Stormwater Center on permeable pavements. This full-day training included field visits to a variety of on-the ground porous pavement installations throughout the region. Participants learned key design principles necessary to successfully design, evaluate, specify, and install porous pavement for stormwater management. (December 2009).

- Two workshops at the University of New Hampshire Stormwater Center in Durham, NH to observe conventional and Low Impact Development storm water treatment systems in operation. The Stormwater Center is independently verifying the effectiveness of the various treatment systems to remove pollutants from runoff and reduce impacts associated with storm flows. (March 2006 and May 2007).

- 2ND National Low Impact Development Conference – North Carolina State University held in Wilmington, NC, (March 2007).

- Designing Bio/Infiltration Best Management Practices for Stormwater Quality Improvement – University of Wisconsin (Madison, WI) (November 2005).

- Stormwater Design Institute – Center for Watershed Protection (White Plains, NY), (December 2004).

- Engineering and Planning Approaches/Tools for Conservation Design – University of Wisconsin (Madison, WI) (December 2003).

- Law for Design Professionals in Connecticut – Lorman Education Services in Trumbull, CT (September 2002).

- On-site Wastewater Facility Design – University of Massachusetts in Amherst, MA (May 2002).

- The Northeast Onsite Wastewater Short Course & Equipment Exhibition – New England Interstate Water Pollution Control Commission in Newport, RI (March 2002).

- Designing On-site Wetland Treatment Systems, University of Wisconsin, (Madison, WI) (October 1999).

- Cost Effective Drainage System Design – University of Wisconsin (Atlanta, GA) (November 1997).

- Treatment Wetlands, University of Wisconsin, (Madison, WI). "Creating and Using Wetlands for Wastewater Disposal and Water Quality Improvement" (April 1996).

- Alternative On-site Wastewater Treatment Systems, New England Intrastate Pollution Control Commission's On-Site Wastewater Task Force in Westford, MA (November 1994).

- Stormwater Quality, University of Wisconsin, (Portland, ME). "Designing Stormwater Quality Management Practices" (June 1994).

LOW IMPACT SUSTAINABLE
LID
DEVELOPMENT
TRINKAUS ENGINEERING

LOW IMPACT SUSTAINABLE DEVELOPMENT PROJECTS

LID Regulations and Design Manuals

- **Town of Tolland. CT –** Prepared amendments to Town of Tolland Zoning, Subdivision, Inland Wetland regulations and Road Design Manual to incorporate Low Impact Development standards. Wrote "Design Manual – Low Impact Development – Storm Water Treatment Systems – Performance Requirements – Road Design & Storm Water Management" prepared for the Town of Tolland; October 2007. The Town of Tolland was awarded the Implementation Award by the CT-APA for the LID regulations and design manual in December 2008.

- **Town of Plainville, CT –** Planimetrics was the lead consultant on this project. This office performed the technical regulatory audit to identify barriers to the implementation of LID. These barriers were removed from the regulations to provide for the implementation of LID. A LID design manual was written by Steve Trinkaus to address specific development/stormwater issues for the Town of Plainville. The regulatory changes and LID manual were adopted by the Planning and Zoning Commission in September 2010. This work was funded by the Farmington River Enhancement Grants from CT DEP.

- **Town of Harwinton, CT –** In conjunction with Planimetrics of Avon, CT, the existing land use regulations were evaluated for barriers to the implementation of Low Impact Development (LID). The project team suggested changes to the land use regulations to encourage the application of LID in the community. Steve Trinkaus defined design processes and strategies to encourage the implementation of LID in the town. This work was funded by the Farmington River Enhancement Grants from CT DEP.

- **Town of East Granby, CT –** Planimetrics was the lead consultant on this project. This office performed the technical regulatory audit to identify barriers to the implementation of LID. These barriers were removed from the regulations to provide for the implementation of LID. Steve Trinkaus prepared a LID Design Manual and LID Educational document for the town working with Gary Haynes, the town planner. This work was funded by the Farmington River Enhancement Grants from CT DEP.

LID Projects

- **Garden Homes Management –** Westport, Connecticut – 48 unit residential apartment building being developed under 8-30g (affordable housing) on 1 acre site directly tributary to West Branch of the Saugatuck River. All construction activities are located outside regulatory setbacks to tidal wetland and 100-year flood boundary. Stormwater management system was designed to fully infiltrate the runoff for all storm events up to and including the 100-year event and reduce pollutant loads to existing levels as wooded parcel.

- **Jelliff Mill, LLC** – New Canaan, Connecticut: Redesigned the site layout to create ten single family residential units on a site overlooking the restored historic Jelliff Mill dam on the Noroton River. The site design uses two sections of permeable pavement and a Bioretention system to infiltrate the runoff from the proposed impervious areas on the site. Due to the presence of sand and gravel soils, all runoff from the impervious areas will be infiltrated up to and including the 25-yr storm event (5.7" of rain/24 hrs). Fully constructed and occupied.

- **SRG Family, LLC** – Southbury, Connecticut: Design final site grading for 38,000+ sq.ft. Medical services building and approximately 225 parking spaces in order to maintain overland flow patterns. Designed multiple LID treatment systems consisting of bioswales with weirs, Bioretention systems and Permeable Pavement (asphalt) to handle runoff from all impervious area on the project site. The LID treatment systems are capable of fully infiltrating the runoff from a 50-yr storm event will virtually eliminating the discharge of any pollutants to the adjacent wetland area. Currently pending before Inland Wetlands Commission for modification of original approval.

- **Farmington River Watershed Association** – Winchester, Connecticut: Designed stormwater retrofit for existing 1 acre paved parking area at the science building of the Northwest Community College to treat runoff prior to discharge into the Still River. Retrofit consists of forebay and Bioswale to treat runoff from parking area and building roof. Currently at Bid stage.

- **Garden Homes Management –** Southport, Connecticut: Designed site to support 96 unit apartment building and 115 parking spaces. Site contains both freshwater and tidal wetlands. Stormwater management design required to provide Groundwater Recharge Volume & Water Quality Volume in addition to reducing the post-development peak rate of runoff from the 10-yr rainfall event to the pre-development peak rate of runoff from the 2-yr rainfall event. The stormwater management design includes grassed swales, Bioretention systems and underground concrete galleries to meet all of these stormwater requirements. Due to favorable soils on the site, the site will likely be a zero discharge site. Currently under legal review.

- **Garden Homes Management** – Milford, Connecticut: Designed site to support 257 unit apartment building with 295 parking spaces. Stormwater management design required to provide Groundwater Recharge Volume & Water Quality Volume in addition to reducing the post-development peak rate of runoff from the 25-yr rainfall event to the pre-development peak rate of runoff from the 25-yr rainfall event. The design utilizes a Bioretention system, two underground galleries systems as well as a small detention basin to meet all of the stormwater requirements. Currently under legal review.

- **Garden Homes Management** – Milford, Connecticut: Designed site to support 21,888 sq.ft. building (three stories) containing 36 studio apartments and 45 parking spaces. Permeable pavement and Bioretention will be used on the site to treat runoff for water quality improvements along with reducing runoff volume from the 1-yr to 100-yr storm event. Construction complete and project ready for occupancy.

- **Quickcomm, Inc. –** Newtown, CT**:** Design a parking facility for approximately 140 vehicles to serve an existing corporate use. Runoff from the entire parking facility will be directed to one of seven Bioretention systems. Water quality of the runoff will be improved by the filtration through a specialized soil media and will then infiltrate into the underlying soils. Due the presence of sand and gravel soils, the Bioretention systems will fully infiltrate all runoff up to and including a fifty-year design storm (6.5" of rain/24 hours). Land use approvals obtained in the fall of 2012 and work completed in the fall of 2013.

- **Garden Homes Management** – Fairfield, Connecticut: Designed site to support 32,592 sq.ft. building (three stories) containing 54 studio apartments and 68 parking spaces. Permeable pavement will be used for majority of parking facility. Roof drains will also be directed to permeable pavement system for water quality improvement. Reservoir layer was sized to fully contain 1.7" of runoff from contributing impervious area. By using a raised underdrain an anaerobic condition will be maintained in the bottom of the reservoir, thus providing denitrification of Total Nitrogen prior to discharge to tidal section of Rooster River. Construction complete and project ready for occupancy.

- **Garden Homes Management** – Oxford, Connecticut: Design site plan for 126 units of manufactured housing on 41+ acres. Stormwater management is achieved by the use of linear Bioretention systems (Bioswales) along both sides of all interior roads. After treatment in Bioswales, all runoff is directed to standard detention basins to provide peak rate attenuation from the 2-year to 100-year rainfall event. Approved by Inland Wetlands Agency, Denied by Planning and Zoning Commission. Currently under legal appeal in court.

- **Compton Family Trust** – New Hartford, Connecticut: Design two wet swales systems to convey and filter runoff from road which is currently discharged into West Hill Lake via a paved swale. West Hill Lake has very good water quality and the owner desires this work on this property to become a template for other homeowners on West Hill Lake to prevent adverse impacts of stormwater on the water quality of the lake. Received all necessary land use approvals. Construction to commence in the summer of 2012.

- **Highwood Estates** – Thomaston, Connecticut: Design retrofits for two existing failing detention basins serving existing 50 lot residential subdivision. Retrofits were designed using LID techniques to improve water quality reaching Northfield Brook, an impaired waterway. The larger basin was converted to an Extended Detention Shallow Wetlands to significantly reduce pollutant loads. Due to a limited area, only a forebay and deep pool could be designed for the smaller basin, thus providing measurable improvements in water quality.

- **Farmington River Watershed Association** – Winchester, Connecticut: Design stormwater retrofits consisting of a Bioretention system at the Town of Winchester Wastewater Treatment Plant and a Bioswale at the Town of Winchester Public Drinking Supply facility. These projects are being funded as LID demonstration projects to increase public awareness of LID. The systems were installed in June 2012 and were featured in articles in the Republican American and Register Citizen newspapers.

- **Harwinton Sports Complex** – Harwinton, Connecticut: Redesign stormwater management system for indoor sports facility to use vegetated swales and Bioretention systems. Redesign site grading to eliminate all structural drainage in parking facility. Client saved over $ 40,000 on infrastructure costs by the use of LID treatment systems.

- **Holland Joint Venture, LLC –** Bridgewater, Connecticut: Prepared site plan for 28,000 sq.ft. industrial/light assembly use and 140 parking spaces on 10.94 acres. Utilize Environmental Site Design strategies to preserve large portions of site in natural condition, minimize impacts due to site disturbance, and minimize impacts to wetland/watercourse system by access driveway. Designed five Bioretention systems for storm water management and pollutant removal from all impervious areas.

- **Goodhouse Flooring, LLC** – Newtown, Connecticut: Design site to accommodate 8,800 commercial building and associated driveway and parking areas on 1.0 acre site. Designed eight Bioretention systems to handle runoff from all impervious surfaces. Analyze and demonstrate that State of Connecticut water quality goals will be achieved for the site design.

- **Trade Winds Farm** – Winchester, Connecticut: 24 lot Open space subdivision on 104+ acres of land. Performed all civil engineering design work for project. Notable feature of project is the preservation of 64+ acres of the site as dedicated Open Space. Many LID strategies such as Environmental Site Design, site fingerprinting, volumetric reduction and water quality improvements

were incorporated into site design. Storm water treatment systems utilized vegetated basins, vegetated swales with gravel filter berms, emergent marsh, Bioretention systems, linear vegetated level spreader, and meadow filter strips.

- **Northern View Estates** – Sherman, Connecticut: Five lot subdivision with private road. Design has no direct wetland impacts and only minor intrusions into defined 100' upland review area. Low Impact Development systems, such as vegetated swales and Bioretention were used to treat post-development runoff while maintaining existing drainage patterns to the maximum extent possible.

- **Mill River** – New Milford, Connecticut: Designed 14 lot open space subdivision on 68 acre site. Performed all civil engineering services for project. .LID treatment systems such as a permanent pond/emergent marsh system, linear biofiltration swale, and rain gardens were designed for the site.

- **Byron Avenue Cluster Development** – Ridgefield, Connecticut: Seven lot cluster subdivision on 4 acres. The Stormwater management system consisted of a road with no curbs, grassed swales and constructed wetland with detention to reduce pollutant loads and increases in the peak rate of runoff.

- **The Estates on the Ridge** – Ridgefield, Connecticut: 32 lot open space subdivision on 152+ acres. Over 80 acres of the site will be preserved as Open Space as part of this project. Stormwater will be treated by the use of rain gardens for roof drains, infiltration trenches for footing drains, emergent marsh systems and vegetated swales for conveyance and treatment of road runoff. Designed over 1 mile of proposed road for project. Designed bottomless culverts over several wetlands crossing to minimize direct impact on wetland areas.

- **G & F Rentals, LLC** – Oxford, Connecticut: By utilizing LID stormwater concepts such as grass filter strips, Bioretention in parking islands, Bioretention for roof drains, and infiltration trenches, a total of 54,000 sq.ft. of commercial office space along with 140+ parking spaces was placed on 10 acre site. The project also restored previously degraded inland wetlands on the site.

- **Dauti Construction – Edona Commons** – Newtown, Connecticut: Designed 23 unit affordable housing plan to minimize impacts on delineated wetland areas. Designed three construction wetland systems for the treatment of storm water runoff for water quality renovation.

- **American Dimensions, LLC** – New Milford, Connecticut: Redesigned the storm water treatment systems for a 7 lot residential subdivision. Rain gardens were designed to handle the runoff from all roof areas and proposed driveways. Each rain garden provided the required Water Quality Volume and Groundwater Recharge Volume as specified in the 2004 Storm Water Quality Manual. A Subsurface Gravel Wetland was designed to treat the full Water Quality Volume for runoff from adjacent roads network which drained through the subject property.

- **Molitero Residence** – New Fairfield, CT: Designed five Bioretention systems to mitigate both volumetric increases of runoff and address water quality issues for large building addition to single family residence on Candlewood Lake. Also designed landscape filter strip above lake edge to filter runoff from up gradient lawn area. Bioretention systems fully infiltrated 5" of rain in 24 hours from Hurricane Irene in August of 2011. Project was featured in newsletter of Candlewood Lake Authority to demonstrate the effectiveness of LID treatment systems in a lake environment.

- **Multiple single family residences** – Design Bioretention systems to mitigate volumetric increases of runoff due to increases of impervious cover on the lot for large building additions and new

construction including the reduction of volumetric increases up to the 25-yr event (5.7" of rain in 24 hours).

Residential Subdivisions

- **Stone Ridge Estates**, 59 lot residential open space subdivision, Ridgefield, Connecticut (Town of Ridgefield)
- **Oak Knoll**, 14 lot open space subdivision, Ridgefield, Connecticut (Mike Forbes)
- **Ward Acres Farm**, 12 lot open space subdivision, Ridgefield, Connecticut (Sturges Brothers, Inc.)
- **Horblitz Subdivision**, 13 lot open space subdivision, Ridgefield, Connecticut (John Sturges)
- **McKeon Subdivision**, 14 lot conventional subdivision, Ridgefield, Connecticut (McKeon Family Trust)
- **High Ridge Estates**, 5 lot subdivision in historic district, Ridgefield, Connecticut (Scandia Construction)
- **Millstone Court**, 7 lot conventional subdivision, Ridgefield, Connecticut (Sturges Brothers, Inc.)
- **Cricklewood Subdivision** – 12 lot conventional subdivision, Redding, Connecticut (Jay Aaron)
- **Spruce Meadows Subdivision** – 12 lot conventional subdivision, Wilton, Connecticut (Piburo Builders)
- **Noroneke Estates** – 12 lot open space subdivision, Ridgefield, Connecticut (John Sturges)
- **Lynch Brook Lane** – 7 lot open space subdivision, Ridgefield, Connecticut (Sturges Brothers, Inc.)
- **Ledgebrook Subdivision** – 27 lot conventional subdivision, Southbury, Connecticut (Conte Family Trust, LLC**)**
- **Seven Oaks** – 19 lot open space subdivision, Ridgefield, Connecticut (Basha Szymanska)
- **Applewoods** – 29 lot conventional subdivision, Bethel, Connecticut (Gene & Joe Nazzaro)

Third Party Engineering Reviews

- **Groton Open Space Association** – Wal-Mart Super center, Mystic Woods Age Restricted Development, and changes to stormwater standards in the Town of Groton regulations – Groton, Connecticut. Focus of review was on stormwater management plans to address water quality and runoff volumes per the CT DEP 2004 Storm Water Quality Manual as well as the adequacy of the erosion and sedimentation control plan for the proposed development.
- **Town of Tolland Planning & Zoning Commission** – Star Hill Athletic Complex with focus on water quality impacts on existing impaired waterway. Focus was on suggesting changes to stormwater management system to comply with recently adopted Low Impact Development requirements in the Town of Tolland.
- **Town of Newtown Inland Wetlands Commission** – Sherman Woods – 38 lot residential Subdivision with focus on stormwater management and water quality. Review stormwater management plan for compliance with CT DEP 2004 Storm Water Quality Manual to address water quality issues being directed to high quality wetland systems. Also review erosion & sedimentation control plan for adequacy and compliance with CT DEP 2002 Guidelines for Soil Erosion & Sediment Control.
- **Town of Winchester Inland Wetlands Commission** – 30,000 sq.ft. Commercial building with grading and stormwater management within 100-yr flood plain. Plan reviewed focused on impacts to floodway and 100-year flood plain as a result of the placement of significant fill within the flood plain.
- **Town of Southbury Inland Wetlands Commission** – 35,000 sq.ft. Medical office building proposed in close proximity to inland wetlands & watercourses. Review focus on the adequacy of the

stormwater management plan to address water quality and runoff volumes prior to discharge into on-site wetland areas.

- **Friends of Litchfield** – Stop & Shop proposal on existing retail site proposing an increase of impervious area of 1 acre directly draining into an aquifer protection area. Focus of review was on adequacy of stormwater management system to address water quality of runoff and prevent further off-site adverse impacts.
- **The Regency at Ridgefield** – Proposal for contractor's yard on steep slope immediately uphill of existing pond and wetlands. Project proposed removal of over 45,000 cubic yards of earth and rock to facilitate construction of building. Focus of review was on adequacy of erosion control and stormwater management plan to prevent discharges of pollutants to receiving pond.
- **Friends of Oswegatchie Hills Nature Preserve, Inc. and Save the River, Save the Hills, Inc**. – Review of preliminary site plan for 840 unit of affordable housing on a 230+ acre site directly adjacent to the Niantic River submitted for a zone change to the Planning and Zoning Commission. Focus of review was on stormwater management and impacts to down gradient wetlands, including the Niantic River.
- **Town of Brookfield Inland Wetlands Commission** – The Enclave at Brookfield, an affordable housing project with 187 units on 9.8 acres proposing filling of wetland, locating stormwater basin within inland wetland area and a significant increase of impervious. Review focused on adequacy of stormwater management system to address water quality, runoff volume and peak rate changes due to development in accordance with CT DEP 2004 Storm Water Quality Manual and local land use requirements; review of erosion & sedimentation control plan for compliance with CT DEP 2002 Guidelines for Soil Erosion & Sediment Control and local land use requirements.
- **Town of Brookfield Inland Wetlands Commission and Zoning Commission** – The Renaissance, an affordable housing project with 156 units of 5+ acres adjacent to the Still River replacing existing development on the site. Review focused on adequacy of stormwater management system to address water quality, runoff volume and peak rate changes due to development in accordance with CT DEP 2004 Storm Water Quality Manual and local land use requirements; review of erosion & sedimentation control plan for compliance with CT DEP 2002 Guidelines for Soil Erosion & Sediment Control and local land use requirements. Additionally, reviewed issues of development in the floodway and 100-year flood plain of the Still River.
- **Branford Citizens for Responsible Development** – Review of development plans for Costco Store and other commercial development on 45 acres in Branford, CT. Review focuses on stormwater management issues, particularly increased runoff volumes and pollutant loads to be generated by development and whether the proposed stormwater management proposal would adequately address the impacts of these two issues. Both the 2004 CT DEP Storm Water Quality Manual and the Branford Inland Wetland Regulations were used to determine if the plans were in compliance with the applicable standards. The erosion control plan was evaluated for compliance with the CT DEP 2002 Guidelines for Soil Erosion & Sediment Control.

Commercial Site Plans

- **Cannondale Corporation Headquarters -** Bethel, Connecticut
- **Village Bank Headquarters** – Danbury, Connecticut
- **Newtown Hardware -** Newtown, Connecticut
- **Amicus Healthcare Living Centers –** Rocky Hill, Connecticut
- **Nathan Hale Office Building** – Fairfield, Connecticut
- **Ridgefield Recreation Center** – Ridgefield, Connecticut
- **Silver Spring Country Clubhouse & Pool house renovations -** Ridgefield, Connecticut
- **Tiger Hollow Athletic Complex at Ridgefield High School -** Ridgefield, Connecticut

On-site sewage disposal systems

- **Candle Hill Mobile Home Park** – Design Subsurface Sewage Disposal Systems for individual mobile home units. New Milford, Connecticut.
- **Hemlock Hills Camp Resort** – Expansion of campground, design of gravity sanitary sewer and design of subsurface sewage disposal system to handle 4,800 gpd. Litchfield, Connecticut.
- **Old Field Condominiums** – long term inspection & reporting on the condition of multiple subsurface sewage disposal systems serving 40 unit condominium complex with design flows in excess of 15,000 gpd. Southbury, Connecticut.
- **Thorncrest Farm** – Design of on-site sewage disposal system to handle wastewater from milking operation. Goshen, Connecticut.
- **Silver Spring Country Club** – Design of multiple subsurface sewage disposal systems for private country club with average daily flow of 7,000 gpd during peak usage season.
- **Richter Park Golf Course** – Design subsurface sewage disposal system to replace existing failed system for golf club house and year round restaurant with average daily flow of just under 5,000 gpd.
- **Redding Country Club** - Performed soil testing to design a repair to an existing wastewater management system that was experiencing periodic effluent discharges during high use on very marginal soil conditions. Utilized oversized grease tanks for kitchen waste and septic tanks to increase the clarity of the effluent which was discharged by force main to the subsurface sewage disposal system increase the long term functionality of the system. Discharge rate 4,900 gpd.

General Civil Engineering Projects

- **Montgomery Residence**, 10,000 sq.ft. residence with 2.5 acre pond, Redding, Connecticut.
- **Neils Different,** Design 1 acre pond, Ridgefield, Connecticut.
- **Anthony DeLuca**, Design 2 acre pond**,** Redding, Connecticut.
- **Barrett Cram**, Design 0.5 acre pond, Redding, Connecticut.
- **Jay & Eileen Walker Residence**, 27,000 sq.ft. residence, Ridgefield, Connecticut.

Athletic Facilities

- **Kingdome – East Fishkill, NY,** Prepared comprehensive site plan for the construction of an air-supported structure covering 7.96 acres of land area. Project also includes the design of 303 parking spaces, two full size artificial turf baseball fields and three 54-80 artificial turf baseball fields. Designed all site grading and stormwater management facilities to address water quality volume, channel protection volume as well as peak rate attenuation for the 1-yr, 2-yr, 10-yr, 25-yr, 50-yr and 100-yr rainfall events.
- **Tiger Hollow – Ridgefield High School – Phase I**, Design and site artificial turf competition field and track complex. Design access road to provide access to new building containing locker rooms, concessions, media room, and equipment storage areas. Design all utility connections and obtain local permits.
- **Tiger Hollow – Ridgefield High School – Phase II**, Prepare Conceptual Development plan for reconfiguration of existing athletic fields adjacent to the Tiger Hollow stadium.
- **Joel Barlow High School – Redding, CT**, Provide preliminary Master Plan on pro bono basis for reconfiguration and improvement of existing athletic fields at Joel Barlow in response to Falcon Pride stadium proposal. Plan was provided to Region 9 Board of Education for general discussion purposes.

Attachment 3

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December 19, 2018

Ms. Leslie King, Esq.
Murtha Cullina
One Century Tower
265 Church Street
New Haven, Connecticut 06510

Re: Solar Farm – Grassy Hill Road
East Lyme, Connecticut

Dear Ms. King,

At your request, I have reviewed the following additional documents for the solar farm which was constructed on Grassy Hill Road in East Lyme.

1. Site plans prepared for Antares Solar Field by BL Companies, dated: October 9, 2012 and revised to July 16, 2013.
2. Stormwater Management Report prepared for Antares Solar Field by BL Companies, dated: July 16, 2013 (Stormwater Management Report)

None of the information found in these documents changes my conclusions and professional opinions regarding issues with the design of the stormwater management and erosion control plan for the East Lyme solar farm.

Executive Summary of Opinions:

1. The stormwater management report grossly under estimates both the peak rate and runoff volumes which are being generated by the project as it does not consider the solar panels to be impervious. The panels are situated above the ground surface, thus every raindrop which falls on a panel instantly becomes runoff.
2. The applicant failed to account for changes in soil compaction and porosity which resulted from the considerable regrading of the site. The substantial cuts and fills of the site resulted in a soil surface which will not infiltrate and thus will generate more runoff than the undisturbed pre-development conditions.

Developers Stormwater Management Plan and Report:

To further support the professional opinions stated in the executive summary regarding the increases in the peak rate and runoff volumes, I have performed calculations to show the significant increases in the peak rate of runoff and runoff volume are being generated by the existing solar farm on Grassy Hill Road in East Lyme.

I have calculated the changes in both the peak rate of runoff and runoff volumes for that portion of the solar farm which is tributary to the Bialowans property. Based upon the plans and Stormwater Management Report prepared by BL Companies, sub-watershed areas A-1, A-2, A-3, A-4, A-5 and B-1 identified therein were analyzed.

The Time of Concentration value used by BL Companies as well as their total sub-watershed area was used in my analysis. I made three modifications compared to the BL analysis. First, the area of the solar panels was considered as pervious by BL Companies and I considered them to be impervious as all rainfall which falls on the panels is converted to runoff. An impervious surface has a Runoff Curve Number (RCN) of 98. Each panel was shown on the site plan by BL Companies as a separate unit and measured 10' x 35'. To determine the impervious area, I counted the number of solar panels within each sub-watershed area.

The approved site plans BL Companies showed a gap between each panel in a row; however, in the field there is no gap between each panel, so the actual peak rate of runoff and runoff volumes would be higher than the values stated in Table #1 and #2 for Trinkaus #1 and Trinkaus #2. The calculated values for Trinkaus #1 and Trinkaus #2 are based upon a gap existing between the individual panels as shown on the BL Company site plans.

Secondly, the RCN for the gravel roads was changed from 89 to 96. In the HydroCAD Version of TR-55, there are two categories for a gravel road. First, a gravel road (with right of way) has an RCN of 89. This is the value used by BL Companies in their stormwater management plan and is not applicable in this case as the gravel road is simply located within the limits of the solar farm. A gravel road (w/o right of way) has a RCN of 96 according to the HydroCAD program and this condition reflects what was actually proposed by BL Companies and constructed in the field at the Antares Solar Farm.

Lastly, one analysis (Trinkaus #1) was done using a RCN for Lawn in Good Condition on a Class C soil (74) and the second analysis (Trinkaus #2) was done using a RCN for Lawn in Good Condition on a Class D soil (80). The Class D soil designation more accurately reflect the disturbed soil conditions on the site as a result of the regrading and compaction specifications on the approved plans by BL Companies.

Applying these three modifications, the peak rate of runoff for the 2-year rainfall event (3.4" per 24 hours as stated in the Stormwater Management Report by BL Companies) was analyzed; the results are shown in Table #1 below. Peak Rate of runoff is shown as cubic feet per second (cfs). Runoff volume for the two-year rainfall event is shown in Table #2. Runoff volume is measured in acre-feet. (An acre-foot is 1 foot of water over 1 acre of land (43,560 cubic feet of water).)

Table #1

Post-Development Watershed Area	BL Companies	Trinkaus #1	**Net Change/ Percent Change**	Trinkaus #2	**Net Change**
Peak Rate	cfs	cfs		cfs	
A-1	5.36	5.63	**+0.27/5.0%**	7.66	**+2.30/22.9%**
A-2	5.52	6.49	**+0.97/17.6%**	8.25	**+2.73/49.4%**
A-3	7.12	8.35	**+1.23/17.3%**	10.60	**+3.48/48.9%**
A-4	5.11	5.97	**+0.86/16.8%**	7.53	**+2.42/47.3%**
A-5	7.43	14.32	**+6.89/92.7%**	18.13	**+10.70/144.0%**
B-1	3.40	4.15	**+0.75/22.0%**	4.97	**+1.57/46.2%**

Table #2

Post-Development	BL Companies	Trinkaus #1	**Net Change/ Percent Change**	Trinkaus #2	**Net Change**
Runoff Volume	cubic feet	cubic feet		cubic feet	
A-1	0.530	0.556	**+0.026/4.9%**	0.732	**+0.202/38.1%**
A-2	0.545	0.629	**+0.084/15.4%**	0.786	**+0.241/44.2%**
A-3	0.715	0.826	**+0.111/15.5%**	1.032	**+0.317/44.3%**
A-4	0.542	0.624	**+0.082/15.1%**	0.776	**+0.234/43.4%**
A-5	0.774	0.898	**+0.124/16.0%**	1.121	**+0.347/44.8%**
B-1	0.312	0.375	**+0.063/20.2%**	0.446	**+0.134/42.9%**

The results shown in both Table #1 and Table #2 clearly show that both peak rate and runoff volumes are substantially higher when the solar panels are considered impervious.

The engineering standard for the design of a stormwater management is to consider any hard surface above ground or on the ground surface as impervious. The stormwater manuals of the States of Massachusetts, Minnesota, North Carolina and Maryland have sections which specifically address how to handle stormwater from large scale solar farms. Links to these sections are provided below.

State of Massachusetts: https://www.mass.gov/guides/massdep-wetlands-program-policy-17-1-photovoltaic-system-solar-array-review

State of Minnesota:
https://stormwater.pca.state.mn.us/index.php?title=Fact_sheet_on_stormwater_guidance_for_solar_farm_projects

State of North Carolina:
https://files.nc.gov/ncdeq/Energy%20Mineral%20and%20Land%20Resources/Stormwater/BMP%20Manual/E-6%20%20Solar%20Farms.pdf

State of Maryland:
https://mde.maryland.gov/programs/Water/StormwaterManagementProgram/Documents/ESDMEP%20Design%20Guidance%20Solar%20Panels.pdf

The common features in these four manuals is that solar panels themselves could be considered pervious if all of the following conditions are met. If any of conditions are not met, then the solar panels must be considered as impervious.

a. Minimize site disturbance,
b. Prevent compaction of the soils on the solar farm, particularly in the area of the panels and vegetated strips,
c. Prevention the removal of topsoil from the site or replace the topsoil prior to seeding,
d. Maintain or restore infiltrative capacity of the soil,
e. Prevent concentrated flow from occurring,
f. Establishment of a dense vegetated cover on the soil surface.

The Antares Solar Farm on Grassy Hill Road in East Lyme does not meet any of the conditions stated above, therefore the solar panels must be considered impervious in the design of the stormwater management systems.

At the field inspection of the site on October 5, 2018, it did not appear that topsoil was replaced on the site after being removed to permit the mass grading of the site to occur. This observation is based on a visual inspection of the ground surface which did not show dark brown organic soil on the surface. The ground under the rows of panels and between the rows was light brown and very compacted, whereas if topsoil was present, the surface would not be compacted due to the higher organic content found in topsoil.

There is clear evidence in the field that runoff from the solar panels are not infiltrating into the disturbed soils under the entire solar farm. This evidence of erosion and resultant sedimentation is shown in Figure 1 and Figure 2 below.

Figure 1 - Concentrated flow from runoff off solar panel

Figure 2 - Erosion & Sedimentation resulting from concentrated flow

On Sheet GN-1 by BL Companies with a revision date of 7/16/13 under Grading and Utility Notes, note #5 states the following: "The contractor shall compact fill in 8" maximum lifts under all building areas to 95% of the maximum dry density as determined by ASTM D1557 (Modified Proctor Test), or as directed by the Geotechnical Engineer." In my professional opinion, the term "all building areas", mean the entirety of the solar farm. The natural soils

were cut and filled substantially on the site, compacted to the ASTM D1557 standard, which easily and clearly explains why there is no infiltration occurring within the grass areas on the solar farm and more runoff is being created for all rainfall events.

Information on the ASTM D1557 standard can be found at this link: https://www.astm.org/Standards/D1557.htm . The following language was taken from this link and the sentence shown in bold is how the properties of the natural soil would be changed.

NOTE 3: The degree of soil compaction required to achieve the desired engineering properties is often specified as a percentage of the modified maximum dry unit weight as determined using this test method. If the required degree of compaction is substantially less than the modified maximum dry unit weight using this test method, it may be practicable for testing to be performed using Test Method D698 and to specify the degree of compaction as a percentage of the standard maximum dry unit weight. Since more energy is applied for compaction using this test method, the soil particles are more closely packed than when D698 is used. **The general overall result is a higher maximum dry unit weight, lower optimum moisture content, greater shear strength, greater stiffness, lower compressibility, lower air voids, and decreased permeability.** However, for highly compacted fine-grained soils, absorption of water may result in swelling, with reduced shear strength and increased compressibility, reducing the benefits of the increased effort used for compaction **(2)**. Use of D698, on the other hand, allows compaction using less effort and generally at a higher optimum moisture content. The compacted soil may be less brittle, more flexible, more permeable, and less subject to effects of swelling and shrinking. In many applications, building or construction codes may direct which test method, D698 or this one, should be used when specifying the comparison of laboratory test results to the degree of compaction of the in-place soil in the field.

Corrective Action to Remediate the Stormwater Management System:

In order to reduce the runoff being discharged from the solar farm, the existing stormwater management systems must be remediated to provide the Channel Protection Volume (CPV) as specified in the CT DEP 2004 Storm Water Quality Manual. The CPV requires developers to reduce the post-development peak rate of runoff from the 2-year rainfall event to 50% of the pre-development peak rate for the 2-year storm event. The intent of the CPV is to reduce the post-development peak rate, which will significantly increase the duration of flow directed to a receiving stream. By reducing the peak rate, the nominal flow depth in the receiving streams is lowered for the all rainfall event up to and equal to the 2-year rainfall event to the more naturally stable cross-sectional area of the stream, thus preventing adverse changes to the morphology of the stream channel. The following work must be done to the Antares Solar Field in order to have a stormwater remediation plan which provides the CPV:

1. An As-built survey of the entire solar farm done conforming to the following standards.

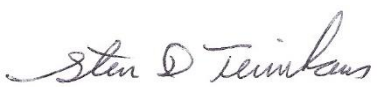
    a. Boundary work and survey location performed to a Class A-2 standards locating all buildings, solar panels, gravel roadways, stormwater management practices (ponds and swales),
    b. A two-foot topographic survey of the solar farm which meets Class T-2 standards. The area of the topographic survey needs to encompass all those areas within the fenced area of the solar farm, including the detention ponds and swales. The

limit of topographic survey must extend a minimum of fifty (50) feet beyond the eastern and southern limit of grading of the solar farm.

2. A revised stormwater management analysis and design encompassing the following parameters.
    a. All solar panels, all buildings or above ground equipment identified as impervious,
    b. The grass on all disturbed areas within the limits of the solar farm shall be considered as Grass (good condition on a Class D soil),
    c. Post-development watershed boundaries shall be established by the design engineer based upon current as-built conditions,
    d. Times of concentration shall be determined by the current field conditions,
    e. Runoff Curve Numbers (RCN) will be determined based upon current field conditions and the parameters stated above,
    f. Post-development peak rates of runoff and runoff volumes shall be determined by HydroCAD or a similar hydrologic model for the two-year rainfall event (3.4"/24 hours),
    g. The size and hydrologic outlets of all the existing stormwater ponds shall be redesigned to provide the Channel Protection Volume (CPV) as specified in the CT DEP 2004 Storm Water Quality Manual as well as attenuate the peak rate of runoff for the 10-year rainfall event. An appropriate overflow spillway shall be incorporated into the design of all stormwater ponds for all rainfall events larger than the 10-year event up to and including the 100-year rainfall event,
    h. A revised site plan showing the modifications to all the stormwater ponds shall be prepared. The site plans shall include all construction details for each stormwater pond and their respective outlet structures,
    i. An erosion control plan, conforming to the CT DEP 2002 Guidelines for Soil Erosion and Sediment Control shall be prepared for the modifications of the stormwater ponds,
    j. A revised stormwater management report shall be prepared with all calculations and pond routing analyses.

The above modifications to the stormwater management plan for the solar farm must be reviewed and approved by a third-party engineering consultant which expertise in stormwater management prior to its implementation. No cost for the implementation of the stormwater pond modifications can be determined until an actual design has been made.

Respectfully Submitted,
Trinkaus Engineering, LLC



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