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# Reduced Impact Development Practices at "Restoration"

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**Abstract.** This paper addresses some of the common environmental issues associated with conventional development, including water supply, water quality, energy, transportation, and open space. It describes an alternative direction that development can take, which can lead to greater resource efficiencies in master planned communities that provide a better quality of life with a reduced environmental impact. It emphasizes the importance of ensuring long-term adherence to measurable, quantitative goals for energy and water consumption and water quality. Throughout, a case study of the Restoration community in Volusia County, FL is described to illustrate some approaches for establishing performance-based standards in new master planned residential communities.

**Keywords:** **W**ater Quality, Water Supply, Energy Efficiency, Residential Development
**PACS:** 01.75.+m, 89.60.-k, 89.65.-s

## GROWTH TRENDS AND ISSUES

In the 25 years from 1980 to 2005, Florida's population grew from about 10 million to roughly 17 million. The US Census Bureau projects Florida will have 11 million more residents by 2030 [1]. Permits for new single-family, detached homes are following Florida's population trends. In 2002, 127,000 permits were issued, and by 2005 the number grew to more than 200,000 [2]. Even with the current slowdown, the numbers remain large for FL and also nationally.

In rapidly growing areas like Tampa Bay, development projects can proliferate rapidly. The majority of the homes are in master planned residential communities where the developer specializes in "horizontal" development, meaning they build the infrastructure (roads, sewer, water, etc.) and amenities (golf course, etc). Builders purchase groups of finished lots and construct houses. The residential community development process generally follows a very similar pattern regardless of the individual company. The land is cleared except for wetlands and then it is reshaped to create high ground that drains to wet or dry retention/detention areas. Roads and infrastructure are built on high ground to service finished lots. The homebuilder brings in additional fill to ensure drainage to the road. Once homes are constructed, lots are "graded out," creating highly compacted soils with little or no topsoil. As homes are finished, in-ground irrigation and turf landscapes are installed to quickly make the

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homes presentable for sale to facilitate the company's cash flow model. To maintain property values, homeowner associations enforce community covenants that preserve these standard landscapes.

The need to protect homes and infrastructure in low lying landscapes and retain stormwater volumes is often addressed by building up lots, creating positive drainage away from home sites and directing runoff toward stormwater conveyance systems. Conventional practice that almost guarantees a stormwater permit uses curb and gutter to capture stormwater and hard pipe it to large stormwater basins at the lowest elevations on the property – often close to natural features in the landscape such as lakes, rivers and sink holes. This can result in stormwater along with pollutants (including dissolved nutrients from fertilizers) by-passing vegetated areas and soils where the water can infiltrate and contaminants might be trapped, and instead allowing the total volume to move quickly to the bottom of the hill with little pretreatment.

Soil compaction is a universal result of the mass grading that occurs in virtually all large projects. The surface bulk density of a typical undisturbed sandy soil generally ranges from about 1.1 to 1.3 g/cm$^3$. In contrast, the highly disturbed soil in urban landscapes can range from 1.5 to 1.9 g/cm$^3$ and compacted fill soil around a building pad and road rights of way can be 1.5 to 2.1 g/cm$^3$, which is approaching the bulk density of concrete pavement (2.2 g/cm$^3$) [3]. The runoff characteristics of highly compacted urban soils approach that of impervious surfaces, especially in large volume or intense storm events. In North Central Florida's sandy soils, researchers found that construction activity and compaction reduced infiltration rates by 70 to 99 percent [4]. In addition to contributing to runoff, soil compaction limits root penetration and growth of landscape plants, and the impacts can continue for years to decades, depending on the degree of compaction and efforts to mitigate. Plants growing in compacted soils that have reduced capacity to hold water (and nutrients) need supplemental irrigation and fertilization. They are also likely to be more susceptible to environmental stress, increasing vulnerability to insects and disease and the likely use of pesticides. Furthermore, any stormwater practices that rely on soil infiltration will be less effective if the underlying soil is compacted. These are examples of how the decisions made during the development process can have long-term implications.

The Program for Resource Efficient Communities began working with master planned community developers because they are in fact the people who are making the decisions about how we build and establishing the foundation of the landscapes that will be maintained by homeowners and lawn care companies. The decisions that developers make can establish practices as de facto standards that are applied all over the state of Florida. The permitting process for large developments includes many stages and many opportunities to define the characteristics of a project's site planning, landscaping and housing. These characteristics are codified in various legally binding documents such as Development Orders (DO); Site Mitigation and Management Plans; and Conditions, Covenants and Restrictions (CCRs). As problems related to water supply, water quality and energy become critical, developers have shown a willingness to plan their projects more strategically.

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## WATER SUPPLY

Florida's water supply is a growth issue of major concern. Demand and withdrawal rates from the aquifer have grown steadily for years, at a rate greater than population growth, and groundwater supplies have been exceeded in areas like Miami-Dade and Tampa Bay. Water withdrawals from Florida's aquifers and rivers have grown by more than 20 fold in the last 50 years. But when water runs out, development stops. In 2006, local officials of Miami-Dade County approved 17 new projects that were large enough to have a regional impact, thereby requiring state approval by Florida's Department of Community Affairs (DCA). After reviewing the projects, DCA denied all of them based on lack of adequate water supply. In the Tampa Bay area, unacceptable environmental impacts on wetlands and aquatic systems from over-pumping has led to construction of additional surface supply systems based on desalination, which is much more energy intensive (and expensive) than ground or surface water, using 15 times as much energy. For electricity alone, the cost corresponds to $55 for each house. Production of desalination water costs about $2.725/1000 gallons, versus $0.8759/1000 gallons for surface water and $0.2126/1000 gallons for groundwater. Desalination is also technologically difficult. Under the original design, the pretreatment process wasn't rigorous enough to filter out suspended particles, resulting in less efficient and more costly plant operations. When the plant reaches capacity it will be capable of processing 25 million gallons per day, but the amount of freshwater produced will vary, depending on demand, weather conditions, water quality requirements, maintenance and other system constraints. At full capacity, the plant will supply about 10 percent of the region's water needs. Local officials chose to build a desalination plant to add a drought-proof element and to further diversity the region's water supply.

And what is all the water needed for? Among other uses, water from the desalination plant will supply the 30+ already approved master planned residential development projects in south Pasco County. Assuming conservative water use, each new home permitted will use over 100,000 gallons of water annually with over 50% of residential water use going to irrigation. In 2008 the desalination plant produced seven billion gallons of potable water – very conservatively, that's enough to water about 150,000 residential landscapes. As these communities are built-out over the next 15 years, will they continue to follow current practice: designing and installing conventional turf/irrigation landscapes?

There are immediate technical fixes that can address at least part of the problem. Research conducted at the University of Florida is finding that soil moisture sensors that override timer-based controls when soil moisture content is adequate can reduce landscape irrigation water demand by more than 50% with no ill effects on the appearance or viability of turf [5,6,7]. In a comparison of irrigation use by Pinellas County homeowners with or without a rain shut-off device or soil moisture sensor on the irrigation system, homeowners with conventional timer-based controls applied about 10" of irrigation water. With a properly functioning rain shutoff device controller override, they applied about 8", and with a properly functioning soil moisture sensor controller override they applied about 5". During normal or wet rainfall years in Florida, water savings using three commercially available soil

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moisture sensor systems tested ranged from 69-92%, compared to timer-based only irrigation systems. Savings under dry weather conditions ranged from 28-83%, and in both cases turfgrass quality was maintained at acceptable levels [7]. Based on this research we can estimate that if the 208,000 Florida homes permitted in 2005 were equipped with properly functioning soil moisture sensor controls, annual water consumption on just those homes would be reduced by five billion gallons with an equivalent savings on water bills of $32 million. Even further reductions in water usage have been demonstrated by increasing the proportion of landscape area in drought tolerant ornamental plants irrigated only with micro-irrigation [8].

When these practices are implemented as part of a comprehensive plan to measurably reduce water consumption in large master planned community developments, the savings achieved by each homeowner is multiplied many fold. For example, the Restoration development in Volusia County, FL is a Development of Regional Impact (DRI) that covers more than 5,000 acres and will have 8,500 dwelling units. The Restoration project has entered into a "Development Order" (DO) with the City of Edgewater. In the DO the developer has committed to a water budget for the community; avoiding the use of potable water for irrigation; and using an overall compact design with an increased proportion of community landscaped areas and less landscaped area controlled by individual homeowners. This community provides an example of the specific DO language used in setting a community water budget:

> ***"To augment water supply, the Master Developer shall develop and implement a quantifiable water conservation "protocol." It will set water budgets that describe and specify the reduced service levels to be achieved in potable water use and the mechanisms to be employed in order to accomplish the same including, without limitation, specified reductions in irrigated areas within the build envelope of the Project."***

In addition, the DO requires that an integrated stormwater and reclaimed irrigation water supply system be constructed, that smart irrigation systems (soil moisture sensors or ET controllers) be used, and that all homes follow the standards of the Florida Water Star$^{SM}$ program (http://floridawaterstar.com/), a certification program that evaluates water efficiency both indoors and outdoors [9].

## WATER QUALITY

Water quality is another major growth issue – in the aggregate, activities on our individual property and community common spaces have consequences. In the summer of 2005, the St. Johns River had multiple blue-green algae blooms related to nutrient loading. It's important to note that even before these algae blooms occurred, the lower St Johns River had been formally declared an impaired water body [10]. In other words, these highly visible algae blooms were predictable. These algal blooms are not just unsightly and detrimental to freshwater areas, they can also negatively affect coastal and nearshore areas. There is increasing evidence of a direct linkage between nitrogen from fertilizer use and a steadily increasing number of coastal dead

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zones [11]. Current residential landscape practices that combine overwatered turf landscapes with poorly informed fertilizer applications along with inadequate stormwater treatment practices are likely to continue to damage the St Johns River and other water bodies.

If all Florida homes permitted in 2005 followed currently conventional landscape practices, and used UF/IFAS recommended application rates, annual nitrogen use in the State of Florida would increase by roughly 4 million lbs/yr, which translates into about 800,000 50-lb. bags (10-0-0), or 20,000 tons of fertilizer. The aggregate retail cost to homeowners is roughly $7 million (or about $35/yr/household). But the unintended cost of environmental impacts could be much greater. Jacksonville and various partners anticipate spending $70 million per year for 10 years to attempt to get the damage already done to the lower St Johns River under control. Planned community developments are going to play a very important role in what happens going forward, either by exacerbating existing problems or by creating a new model of growth that minimizes impacts on the environment.

Looking again at the example of Restoration, the developer directly addresses the linkage between landscape chemicals and environmental impacts by establishing community standards based on minimal fertilizer inputs. This means that the Conditions, Covenants and Restrictions will be written to discourage fertilizer and irrigation water use. The Development Order language includes the landscaping standards provision that

> ***"To ensure homeowners are in compliance with the requirements for minimal to no added inputs of water and synthetic fertilizers and pesticides, the HOA/CDD covenants shall include provision for a third party field contractor/on-site naturalist for long-term environmental monitoring (including water quality, potable water usage and biodiversity) and education to ensure environmental goals are met" [9].***

## OPEN SPACE/CLUSTERING AND TRANSPORTATION

The original site design for the Restoration development had little or no focus on clustering, resulting in a highly dispersed system of roads, infrastructure and site disturbance (Figure 1). Between the original plan and the 2009 plan (Figure 2) multiple iterations of increased clustering were proposed, which allowed for a greater commitment to a workable mass transit (trolley) system, as well as making it easier to meet its commitments to the specific landscaping goals. The site is low, poorly drained and full of wetlands. The original plan was extensive and included a golf course. Because of the impact on wetlands and natural areas to the west, the original plan was not well received. The developer went back to the drawing board several times and came back with a new plan that still has the same number of units, but is very much more compact. The new design allowed 3,700 acres on the west side to be set aside for conservation, with an extensive recreation trail that will wind throughout the community. Because homeowner lots are much smaller and the golf course was eliminated, water consumption and landscape chemical loading is significantly reduced in the 2009 plan. Also, the compact design will result in a more vertical

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development in the urban areas. There will be more townhouses and two-story single family detached homes, which are generally more energy efficient.


**FIGURE 1.** Original proposed master plan for Restoration with golf course and dispersed infrastructure (plan by Canin Associates).

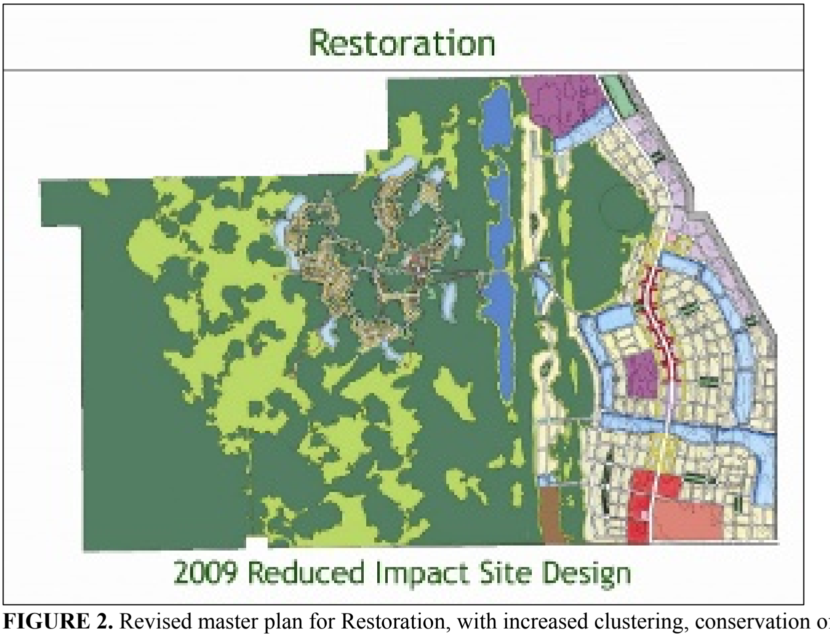


**FIGURE 2.** Revised master plan for Restoration, with increased clustering, conservation of wetlands and uplands on the west side of the property and the facilitation of a transit corridor (plan by Canin Associates).

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Because of its compact design, the community lends itself to a lineal transit system along the major thoroughfare. The developer has committed to building a trolley to accommodate travel within the community. This is significant since the community will have internal schools and shopping. Naturally, this should result in "trip capture," since residents will have less need to get on the Interstate just east of the site. For some residents, the Town Center will provide a workplace, with 3.5 million square feet of commercial space, in a transit-oriented, New Urbanist design.

## ENERGY

More recently among growth issues the focus has been on Florida's energy supply. Electricity in Florida is produced predominantly by burning natural gas and coal. To get a good sense of the flow rate of energy required to sustain Florida's energy demand, first imagine a single hopper car filled with coal. That single car amounts to approximately 357,000 kWhr of energy. Now imagine a coal train 14,000 cars long (almost 160 miles). Florida will require one of those trains every year just to meet the 5 billion kWhr/yr expected demand resulting from homes permitted in 2005. Power plant capacity to meet this growth is projected to be about 1000 mW/yr. Unfortunately, coal's relationship to $CO_2$ generation and global warming is real and is becoming an intractable political problem.

So, if supply has become politically difficult, maybe it's time to really get serious about demand side management. Housing creates the greatest demand for energy and offers the greatest opportunity for improving resource efficiency. If we're going to keep building new homes, that's an obvious place to make some major commitments. Homes that use energy levels well below those in conventionally built homes are even beginning to qualify for carbon credits that can be sold. In 2004 the Program for Resource Efficient Communities at the University of Florida built the model center in Madera, a "green" subdivision in Gainesville, Florida. The home was built to very high energy efficiency standards in collaboration with Steven Winter Associates and DOE's Building America program. It was sold in December 2006. One year after the new owners moved in, their energy consumption was compared to other homes of the same size built during the same period in Gainesville. The home and its owners performed very well, consuming only half as much as comparable homes. In March 2008, as a means of recognizing the home's energy efficiency, Gainesville Regional Utilities "bought" 8.6 tons of carbon credits or $CO_2$ emissions avoided.

Early research has found that the ENERGY STAR program successfully reduced energy consumption in Florida homes. A Gainesville study compared energy use in the Energy Star community Mentone and four other subdivisions not built to Energy Star standards. All of the homes were built during the same period and were in the same size range. The total energy demand in the Mentone homes averaged 15% less than in the other neighborhoods [12]. Because of this type of research, the University of Florida and others groups encouraged adoption of certification programs such as ENERGY STAR.

If all of the 208,000 single-family, detached homes permitted in Florida in 2005 were built to the ENERGY STAR standard and reduced their energy consumption by 15%, annual demand for electricity would have been reduced by more than half a

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billion kWh/yr, utility bills would be reduced by $70 million/yr, and annual $CO_2$ emissions would be reduced by 1.6 billion lbs. This is equivalent to reducing the rate of growth in the number of hopper cars of coal coming to Florida by more than 2,000 a year (the train is now only 137 miles long). But, it's important to understand that energy and water use at the meter is what counts, not labeling of home construction. Recent data suggests that we should look again at how the green building certification programs are being applied and more importantly at whether homeowners are using the green buildings they purchase to their full potential of energy and water conservation. A recent review of the relative performance of the homes originally studied in 2000 found that the ENERGY STAR homes were still more efficient than the standard homes, but not by as much as certification standards would have suggested. In fact, energy consumption in Mentone's ENERGY STAR homes seems to have been steadily climbing. Maybe of even greater concern, it appears that recently built homes in ENERGY STAR communities are in some cases using more energy than conventionally built homes [13].

That means that monitoring of measured performance needs to be incorporated into development plans in conjunction with solid commitments to reduce energy consumption. The Restoration project DO requires that all ductwork and air handlers be in conditioned space and that every home be pre-wired and pre-plumbed to the roof deck in support of solar PV and thermal. Also, all homes must qualify for the DOE Builders Challenge program, meeting a HERS Index Score of 70 or less. The community's more compact design will make it easier to achieve the energy savings that will be needed. The DO also addresses source control in the landscapes and the use of ecologically enhanced stormwater basins. It will also reduce edge effects and create opportunity for more effective water treatment in retained natural areas. One take home message of the Restoration case study is that in designing master planned communities, developers must take a very long view, since completion of large projects can easily take more than 15 years. In these circumstances developers are beginning to see resource efficiency as a requirement for their projects as a regulatory permitting issue. They are also beginning to see it as sales issue, considering what homebuyers will be looking for in 15 years.

## CHANGING DIRECTIONS

The changing energy and water environment of Florida and the Planet will create new regulatory requirements and new opportunities for those willing to evolve their business plans. California now requires developers to estimate the carbon footprint of their projects and to integrate specific plans to reduce greenhouse gas emissions into their projects. In 2007 Florida's Governor openly committed his administration to work toward reducing Florida's greenhouse gas emissions. In 2008 the Florida legislature enacted a bill similar to California's carbon footprint bill, known as HB 697, which establishes new requirements for local planning that address greenhouse gas reductions through energy efficient land use patterns and transportation planning. In conjunction with better planning, a comprehensive demand side management approach may offer a partial solution to the conundrum of how to reduce the rate of growth in greenhouse gas emissions while allowing Florida to continue growing.

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There is also a very real possibility that carbon trading will become a reality in the United States. If it does, then actual measured performance will be the only thing that counts. Florida's political leadership is working to establish Miami as a center for global carbon trading, linking Europe with South America. On a policy level, this concept and other carbon trading ideas all need to be supported with research and evaluation to verify that the playing field is level. Once that's known, then certification and incentive programs can be structured to prioritize best practices. Professionals can be educated regarding the prioritized best practices and bring them to implementation. Finally, the implemented practices need to be monitored and their performance measured, allowing iterative improvements in the recommended practices.

Another game changing concept is the realization that quantifiable performance incentives can be implemented at both the household and development scales for energy management. Master planned developments have opportunities to take advantage of economies of scale and new construction to optimally implement smart grids and household controls. Ports for plug-in vehicles can also become part of the community management system. Energy management at the scale of thousands of homes can be brokered to utilities for the financial benefit of the communities.

We can also expect to see regulatory changes and business opportunities arising from the challenges of supplying water and maintaining water quality for a growing population. For example, many local governments are already being required to develop Basin Management Action Plans to implement Total Maximum Daily Load requirements under the Clean Water Act [14]. When local governments in Florida started considering ordinances to restrict fertilizer use on landscapes as one way to deal with the growing number of impaired waters in their jurisdictions, a debate began that has involved members of the Green Industry, environmental groups and the university communities. Local governments face high cleanup costs to return their waters to their designated uses. In the current reality of landscapes being installed on disturbed and fill soils and the known tendency of homeowners and landscape maintenance personnel to over-irrigate [8], local governments have reason to be cautious. However, instead of debating whether or not fertilizers should be banned during the summer rainy reason, maybe we need to ask a different set of questions. Most importantly, why are we still trying to grow landscapes on the artificial conditions we create during the development process instead of changing the development process to promote landscapes that do not depend on irrigation, fertilizers and pesticides to exist? We should be striving for development practices that result in healthy, intact soils in areas that will be landscaped and choosing plants that are ecologically adapted to that particular environmental condition. This can be achieved by incorporating greater use of ecological principles into the design process [15]. By increasing focus on the soils and moisture regime left behind by the development process and matching plant palettes more strategically with site specific characteristics, landscapes can be maintained with minimal water and fertilizer input requirements, thereby reducing associated energy use in addition to protecting water resources.

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## GUIDELINES FOR NEW DEVELOPMENTS

It is only through a change in the fundamental way development occurs that current and future challenges will be met. Some of the practices most likely to play a part in successfully reducing energy and water consumption and avoiding further impairments to water bodies include the following:

- Create compact/clustered designs that reduce building/transportation energy use and horizontal infrastructure and conserve more natural areas.
- Avoid construction in the 100-year floodplain.
- In low lying areas where fill and site grading are required for slab on grade construction, use stem wall or pier construction to raise the first floor elevation and minimize need for fill.
- Where fill is required and soils exposed to surface runoff, evaluate soils for possible water quality concern such as leachable phosphorus.
- Minimize soil disturbance and rehabilitate disturbed and compacted soils.
- Preserve/re-establish shade tree canopies.
- Minimize/eliminate fertilization in conjunction with the above practices.
- Implement lot scale low impact development (LID) practices.
- Eliminate all irrigation w/ potable water.
- Use dual pipe, dual meter systems for irrigation.
- Minimize irrigation even if using reclaimed/reuse water.
- Manage/require total community water budgets.
- Set up funding mechanisms through the HOA/CDD for environmental monitoring and education.
- Create incentives through the HOA/CDD for homeowners to reduce energy usage.

In Florida's development environment, new growth will happen quickly once the economy improves. Green building certification programs are in place and are growing in popularity, but achievements need to be measured in terms of actual reductions in energy and water consumption and not just in having received a certification based on a check list of practices. Developers are not resistant to looking at new ways of doing things and are finding that multiple benefits are possible. The developer of Restoration calculated that the changes made in the site design will provide a net savings of $14 million from elimination of the golf course, reduced earthwork, reduced roadways and stormwater infrastructure savings, among others. This figure includes $25 million being put into the transit system, so arguably the total savings is closer to $40 million.

Energy, water supply and water quality issues are already critical in rapidly developing areas. Master planned community developments are legal entities and can be organized to actively promote the design, construction and management of resources to minimize wasteful consumption and avoid negative environmental impacts. Having quantitative standards in place is as important as making sure that all those involved are appropriately trained and motivated. The key is open access to

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accurate information and a strategic commitment to achieving measurable performance goals.

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