

Social and Institutional Barriers to Stormwater Infiltration¹

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Introduction

To assess the social and institutional barriers to the infiltration of stormwater first requires a recognition of the diversity of practices by which such infiltration might be achieved. For if we do not recognize this diversity, we may fail to see that the barriers to infiltration vary with the specific practice at issue. An early section of this report tries to get this point across. With this warning in place, we give the following brief overview of barriers to infiltration practices.

Foremost among the barriers are municipal officials and municipal (especially zoning) ordinances. The municipal officials most often indicated are the engineers who review stormwater plans for a municipality and the municipal staff connected with city services and public works. The engineers are often portrayed as tied down by existing ordinances (which likely codify stormwater practices a generation or two old) or as habitually committed to the standard practices of their profession (*e.g.* curb & gutter, wide streets, detention basins). Our research indicates that engineers are more of a barrier when they are in this official role than in the role of consultant to a developer. Municipal staff, by contrast, see urban infrastructure from the point of view not of its role in stormwater management, but in its relation to the services they provide. They tend to oppose infiltration practices when they appear to conflict with such services. On the municipal level, then, getting infiltration practices in place means overcoming patterns of behavior and law and convincing municipal staff that infiltration practices can be harmonized with the multiple uses to which urban infrastructure is put.

Important barriers also appear to lie in the structure of the building industry, especially in the case of parcel-scale infiltration practices. The developer who is legally charged with creating a stormwater plan often deals with stormwater on the level of the whole plat, leaving the details of each parcel to the builder who follows. For a developer's stormwater plan to include parcel-scale practices would mean having to resort to some mechanism to make sure builders and homeowners carry the plan through. And even if a developer is willing to make such arrangements (and has the experience and means to do so, a separate matter), the authorities approving his plan may not have enough confidence in such arrangements to permit them.

Homeowners come in as barriers on two decidedly different planes. They enter when an infiltration practice would be located on their property, where it is subject to a homeowner's acceptance, understanding, and maintenance. In particular, homeowners who are younger and enjoy gardening appear more likely to take on a rain garden. And if infiltration facilities are instead to be maintained by a condominium or homeowners association, then the quality of that organization and its effectiveness at collecting fees presents another challenge, and a barrier if not well met. On another plane, they enter as a political constituency putting pressure on local officials, sometimes to the detriment of infiltration practices.

The costs of infiltration practices—whether as ongoing maintenance fees or as investments in initial development and building—is an obvious potential barrier. By and large, initial construction costs do not appear to be a substantial barrier. Many of our interviewees agree that infiltration practices would mean a net reduction in costs if adopted. Even those who have found higher costs in moving toward infiltration practices believe the cost increments are only marginal. However, as with the assessment of barriers more generally, issues of cost vary with the practice at issue. And we have sometimes heard that even if regulators have allowed

infiltration practices, their reluctance has led them to require redundant, traditional facilities, denying to a developer the cost savings infiltration might offer.

This brief summary of barriers might sound imposing, even discouraging. But that is only because it is focused merely on the barriers, not on the examples of surmounting them we have seen. A section of the report is in fact devoted to what we call “the chemistry of success.” Although this section falls well short of indicating how to get around or over all barriers, it points to institutional mechanisms, planning tools, and regulatory relations that have helped get infiltration practices on the ground.

Data

The data collected for this report included seventeen interviews with key players in stormwater management, including public officials, engineers (working in public agencies and private firms), and developers in areas surrounding Dane and Milwaukee counties. Data collection also included two focus groups on rain gardens with homeowners from Maplewood, MN. Maplewood was chosen because the developments in our primary study areas with rain gardens were only in planning or early building stages, whereas rain gardens had already been installed in Maplewood, meaning homeowners already had experience living with and maintaining them. It should be noted that the rain gardens in Maplewood were installed as retrofits in communities suffering poor drainage. It would also have been useful to study homeowner experience with rain gardens in new developments, but opportunities to do so are only now becoming available in our primary study areas. The specific values and limitations of the retrofit studies will be noted, both in the main text here as well as in Appendix A, which is devoted to the retrofit focus groups.

Five of the seventeen interviews centered on specific cases, on developments in which infiltration practices have been incorporated. These interviews are marked in the bibliography by an asterisk. The developments include those of Bielinski Brothers Builders, Inc. (the Prairie Glenn subdivision in Germantown, WI; the Willowbrook subdivision in Oak Creek, WI; and the Auburn Hills subdivision in Caledonia, WI), Heffron & Associates, Inc. (the Waters Edge subdivision on Lake Wisconsin and the St. Francis subdivision in Cross Plains, WI), and ABS Global in DeForest, WI.

The results reported here are often given in the exact words of our interviewees. References to the interview from which comments came follow each such citation, including the minutes and seconds into the interview where the comment is found. Quotations taken from longer interviews will also have a “1” or “2” to indicate the first or second interview segment. As a general rule, the report tries to indicate the role of the interviewee (whether developer, regulator, consulting engineer, etc.). We feel such indication will improve the interpretive position of the reader. We also feel that our most reliable conclusions are those upon which our informants (in spite of their differing roles) seemed to agree. Consequently, we specifically note such broad agreement when it occurs, as for instance that the willingness of developers is not a major barrier to infiltration practices.

The institutional setting

Data collection for this project focused primarily on two areas of Wisconsin, in and

around Dane and Milwaukee counties.² As will be apparent from the following couple of paragraphs, even though these two areas are within the same state and are well-nigh adjacent, there are between them substantial differences in the institutional framework of stormwater management. That such differences exist even here should caution against using the results of this research to infer how institutions do or should govern stormwater management elsewhere. Here are a few such differences.

Both Dane and Milwaukee counties have regional planning commissions (RPCs). In Dane County the commission boundaries are identical with county boundaries, whereas Milwaukee County falls within the Southeastern Wisconsin Regional Planning Commission (SEWRPAC), which, as its name indicates, encompasses multiple counties. The important difference between these planning commissions for our purpose is that the Dane County RPC has established the practice of reviewing the specific content of stormwater management plans for developments requiring sewer extension with an eye to promoting infiltration. SEWRPAC does not. It should be noted that although the Dane County RPC promotes infiltration, there is dispute as to whether they have much practical effect (Sullivan 1, 27:31).

Another county-level agency, the Dane County Land Conservation Department, is very effective at getting infiltration practices incorporated into new developments, particularly developments that fall under county zoning, which mainly means developments occurring in unincorporated areas of the county (the influence of the Dane County LCD is not, however, limited to unincorporated areas). The Dane County LCD effects infiltration practices through its role as advisor to the county zoning board. It appears that no other agency in the county is as effective as the LCD at getting infiltration practices on the ground. The difference with the Milwaukee County Land Conservation Department could not be more stark; the Milwaukee County LCD appears to play almost *no* direct role in getting infiltration practices on the ground. Its negligible effect on infiltration practices is due in large measure to the absence of unincorporated lands in Milwaukee County. However, in the multi-county area covered by SEWRPAC, there are unincorporated lands, in the development of which SEWRPAC does review stormwater plans, thereby performing the function of the LCD in Dane County. However, SEWRPAC is not encouraging infiltration nearly to the same extent, partly because of differences in the physical setting taken up in the next section.

Within the last two years, both Dane and Milwaukee counties have seen the passage of new area-wide stormwater management regulations, in both cases setting a new context to which municipal regulations must now minimally conform. In Dane County the new regulation took the form of a county ordinance. By contrast, the Milwaukee County regulation issued from the Milwaukee Metropolitan Sewerage District (MMSD) through its delegated rule-making authority. As of January 1, 2002, the MMSD “will have to review the stormwater management

²The exception being the focus group research with homeowners in Maplewood, MN, noted earlier.

plans” of “any project in their watershed” (Engelking 2, 15:43; also Shafer 1, 8:48).³ The prominent role of the MMSD apparently derives from a difference in geography and extent of development; the district is responsible for water flows throughout the extensively developed Milwaukee River basin.

Although these are some of the major differences between the two study areas, they do not exhaust such differences. However, they serve the purpose here of indicating just how substantial can be the variation in institutional setting, even between two areas in which one might at first blush expect to find close similarity.

The physical setting

In addition to the institutional differences just noted, one difference between our two study areas was noted early and often, a difference in the permeability of the soils:

In the majority of the county [Milwaukee]...the soils...are very tight (Mick 5:31).

Although the soils in Dane County are by no means uniformly hospitable to infiltration, there are at least broad areas conducive to infiltration.

This difference in soils brings along with it two related barriers. The first is that tight soils make Milwaukee area homeowners more subject to basement water problems, a problem at the top of the list of homeowners’ concerns according to the head of the Milwaukee Metropolitan Builders’ Association (Muroney 1, 2:47; 34:32). The second is an area-wide problem of seepage from the ground into the sanitary sewer system:

One of the problems in southeastern Wisconsin...you have to remember is we have severe sanitary sewer infiltration problems, particularly in the Milwaukee metropolitan area. That’s why we have overflows. That’s the problem with the whole system. And to be real honest the worst thing you can do there is promote infiltration...because it just aggravates that problem (Biebel 30:58).

However, another prominent engineer in the county who acknowledges these concerns, nonetheless finds the position just quoted too categorical (Shafer 1, 1:00; 2:12). And even if soils in the Milwaukee area are less conducive to infiltration, the MMSD has begun to promote roof-top infiltration (“green roofs”) with “soils” designed for the purpose and “porous pavement” projects (Shafer 2, 3:17; 2, 7:24).

In addition to differences between our study areas in soil permeability, there is the important difference that the Milwaukee area does not face the same groundwater problems as

³On municipal conformity, see the MMSD rule, section 13.11.(9). On MMSD review of stormwater plans, consult section 13.12.(1). Both are available at www.mmsd.com/stormwaterweb/PDFs/mmsdc13.pdf.

Dane County.⁴ First, Milwaukee County is much less dependent on groundwater, drawing large volumes instead from Lake Michigan. Second, the uses that are made of groundwater typically draw from a deep aquifer not recharged by infiltration from the land directly above (Biebel 14:37), though the region may come to rely more on the more easily recharged shallow aquifer in the future (Biebel 20:13). Broadly speaking, this interviewee underlined that one major “barrier” to infiltration may simply be the absence of good reasons for it:

Normally if we were doing a stormwater management plan for a community we'd want to have a reason to put in infiltration, a real reason...Maybe there's a shortage of groundwater projected...Maybe...it's a cold water stream. There probably are reasons in many cases. But if there isn't, then you got to say, 'Well, why do it' (Biebel 40:11).

Yet even this interviewee who noted for the Milwaukee area both the physical barriers to infiltration as well as the absence of reasons for it, even he saw a role for infiltration in flood control (Biebel 41:07). Another interviewee added that infiltration in the Milwaukee area can also serve water quality goals (Shafer 1, 6:08).

So as with the institutional setting, so with the physical setting, there was substantial variation between our study areas bearing on barriers to infiltration practices.

Infiltration practices too diverse to be treated as a group with respect to barriers

Views as to whether there are barriers and what those barriers are varied considerably among our interviewees. One felt there were no barriers (Connors & Roa 2, 2:09), while another not only felt sure there were barriers, but claimed “the institutional barriers are obvious” (Bannerman 1, 6:26). The apparent contradiction between these views begins to melt away when we notice that the first view comes from an official whose department has regularly succeeded in getting several kinds of infiltration practices on the ground, such as infiltration basins and “deep tilling,” but who dismisses rain gardens in stormwater management. The second view, by contrast, comes from one who has been advocating the use of rain gardens. Thus, their differing views point not to a confusion as to what is truly going on, but to the fact that the barriers to infiltration practices depend on the specific practice one has in mind. Compare, for instance, the different barriers faced by rain gardens, narrower streets, and conservation subdivisions, here briefly summarized:

Rain gardens- Barriers here include homeowners who want water away from their homes, who don't like depressions or standing water, and who are unwilling to take on the work and/or expense of maintenance. Barriers also include problems of coordination between developers and builders, as well as regulators who do not trust homeowners to maintain such gardens, even if under deed restrictions.

Narrower streets- Municipalities appear to be the leading barrier to improving infiltration

⁴On the problems facing Dane County, see the publication *Regional Trends 2001* published by the Dane County Regional Planning Commission, and publications addressing groundwater cited therein, page 22.

by means of narrowing streets. This municipal barrier arises from the fact that street widths lie within the zoning discretion of municipalities. Yet why they oppose narrower streets is a separate and diverse matter. One common reason given is that the engineers and service divisions of municipalities see wide streets as necessary for the deliver of services, such as fire fighting. One developer recounted a recent zoning struggle:

We worked with them [Caledonia] to allow some narrower streets than would normally be allowed in their subdivisions. And that was a problem convincing their engineering department and their public works department. They don't typically like narrower streets. [The] fire department typically doesn't like narrower streets. But there are documents out there...according [to which] we could go much narrower (Engelking 1, 51:52; also in agreement Fix 27:01; Apfelbaum 1, 54:13; Wardell 1, 27:33).

A design consultant who has repeatedly faced municipal opposition to narrow streets noted that such “documents” include professional manuals (Apfelbaum 1, 56:23). The same consultant has also found it useful to meet such opposition through a practical experiment:

[W]e'll say, 'Why don't we just do an experiment and see how we all feel about it, the results of the experiment (Apfelbaum 1, 55:56; also 1, 54:49).

One developer found that municipal engineers were more willing to accept new practices when local elected officials and planners became excited about a project (Engelking 2, 25:11).

Another less commonly mentioned reason is that wide streets are claimed to be necessary for on-street parking, in spite of the fact that this reason—though once compelling—has lost its cogency as garages—often large garages—have become standard building practice (Moroney 1, 15:57).

Another less typically given reason, though one of potentially high leverage, is the suggestion that municipalities fail to bring into their own calculations the added costs of maintaining larger streets (Moroney 1, 48:46). We do not know how difficult such a calculation would be. But even if it were difficult, the terms of such a calculation would likely be sufficiently consistent across municipalities that a standard method could be worked out and potentially made a regular feature of municipal planning. Service costs might be reduced not only by narrower streets, but by other infrastructure reductions achieved in conservation subdivisions (Moroney 1, 28:35).

Compact/conservation/cluster subdivisions- The possibility for reducing impervious surfaces and introducing alternative stormwater techniques is greatly expanded in what are variously called conservation, cluster, or compact subdivisions. These are developments in which houses are confined to some fraction of the total development area, leaving substantial land in open space.

Such subdivisions have typically been conceived as an alternative form of development for more rural areas (*Rural Cluster Development Guide*, 1996; Moroney 1, 28:35). Such developments promise considerable improvements in infiltration through reductions in impervious surfaces and the availability of preserved open spaces to treat and infiltrate the runoff that is generated. However, because such developments depart so substantially from existing

practices, they face not only the kinds of barriers noted above (specific objections to specific practices such as rain gardens or narrower streets) but broader barriers such as a general incompatibility with zoning ordinances and demands on the expertise of developers beyond the resources of all but the largest firms. These barriers are treated in greater detail below.

In summary, as the last three sub-sections have indicated, the specific barriers encountered to infiltration practices depend on which practices are at issue. If rain gardens be the issue, homeowner perceptions will loom large (as well as other barriers taken up below). If narrower streets are the issue, the reluctance of municipal service providers come to the fore. If the issue is implementing a “conservation” development, broader legal and organizational barriers arise. The point of this overview of how barriers to infiltration vary with the practices at issue is to emphasize the potentially confounding breadth of the general question, “what are the barriers to increasing stormwater infiltration?”

At what scale? plat vs. parcel

Our research began with a clear awareness of the fact that stormwater management practices can be located at different scales, which for convenience will here be distinguished as scales of watershed, plat (whole development) and parcel. We came to this project with the recognition that most stormwater management in new developments is designed at the *plat* level. Although our project team hopes to determine the feasibility of implementing stormwater management at the other two scales, the results reported here bear only on the question of the balance of practices between the plat and parcel scales.

Infiltration at the parcel scale

Our interest in the feasibility of more parcel-scale practices follows from basic principles of stormwater management:

A lot of this is just common sense, you know. It's just a matter of don't concentrate water. Keep it spread out as much as you can. Get it into the ground [] close to the source (Potter during interview with Porter & Ring 1, 61:50).

Secondly, infiltration practices may not scale up well, which is to say they are better suited to small-scale application. This view is held by one of our principal investigators as well as by one of the engineers we interviewed (Steiner 23:39). Given our special interest in promoting parcel-scale infiltration, we begin with barriers to such parcel-scale practices, particularly rain gardens.

The break between developer and builder

Our original view that stormwater management is routinely carried out at the plat level was confirmed (*e.g.* Steiner 36:30). Although not surprised by this fact, we now see more clearly that this tendency may partly be due to the structure of the housing industry. The home building industry is populated with three distinct entities: developers, builders and developer-builders (the

last of these also termed “closed subdivision builders” by one of our interviewees).⁵ The distinction between plat and parcel—a distinction we attend to as indicating alternative geographic scales of stormwater management—happens also to correspond to the distinction between developer and builder when these two functions are separated, when, that is, a developer lays out the lots and infrastructure on a plat, only to turn over the homebuilding and landscaping to a separate builder. So by the time the builder shows up,

...the larger, regional routing and so forth for the stormwater, that’s all done, just like your streets. Your drainage ways are in place, your swales, where your ponds are, where your infiltration basins are (Moore 58:23; also Wardell 1, 6:42).

This separation between developer and builder is not always present; some developers also build out some, even all of the lots on a plat they have laid out. But when the developer is not also the builder, there is potentially a break in the continuity of the development process, with practical consequences for parcel-scale practices. As one municipal official noted, this break complicates whom to hold responsible when something goes wrong (Sullivan 1, 58:10). And as a DNR regulator noted, it would be difficult for a developer to site a rain garden on a parcel prior to the builder coming on the scene:

...[rain gardens] are a very good concept. It has some logistical challenges, though, because...unless a developer is going to be builder as well,...they [the developers] have no idea where the house is going to sit on that lot. So you can’t really plan ahead where you are going to have the rain garden (Moore 39:52).

A private sector engineer added that even if a developer were able to site and build a rain garden, the builder’s equipment and earth moving might easily “destroy it” (Wardell 2, 12:07). Similarly, he noted that the infiltration benefits of “deep tilling” done by a developer could be destroyed by a builder who compacts the soil again with his own equipment (Wardell 1, 4:56 and 1, 19:35).

If parcel-scale techniques are planned by a developer and their installation postponed so as to avoid the just-named threats, then some additional mechanism (*e.g.* deed restrictions or covenants) would be required to communicate the plan to subsequent actors (whether the builder or perhaps the homeowner) and to assure the plan will be executed (Moore 40:15).⁶

In short, the potential break in the process between developer and builder may pose a

⁵An interviewee from the Milwaukee Metro Builders Association indicated that there is a meaningful distinction to be drawn between professional and one-shot developers, the latter being those who decide to develop a large plot they happen to own. He suggests this latter group is more likely to pose compliance problems for regulators (Moroney 1, 21:45).

⁶Deed restrictions of this sort for rain gardens are being tried in Cross Plains in the St. Francis subdivision developed by Heffron & Associates, Inc. (Jopke 2, 28:16; also Heffron, personal communication).

barrier to parcel-scale practices. Just how great a barrier this is we do not know. It depends first of all on how often developers are not builders; it has been indicated to us that most developers around Dane County are *not* also builders (Heffron 1, 35:41). Though the head of the Metropolitan Builders Association indicated that more builders are getting into development to control rising land costs (Moroney 1, 36:06).

Second, it depends on the effectiveness of the means to maintain continuity between developers and subsequent actors. One developer with whom we spoke brought this problem up directly during a discussion of parcel-scale practices, asking:

I put in 14 lots up in the corner. And I sell those off to builders. How do I measure what they're doing? There's got to be an easy way for them...When they send their plans to me for approval—I get a site plan, I get elevations, I get floor plans...So now you need one extra sheet which is [for] stormwater management. Is that something that can be done in a simple enough fashion that the average builder can figure this out, or architect...so, one, they can fill this out and, two, someone like me or the village...can understand it (Porter & Ring 1, 44:44)?

Although his question points directly to the problem of continuity here at issue, the phrasing of his question also points out that even when builders and developers are separate actors, developers already do exercise oversight on lots they have sold off. The issue, then, appears manageable, perhaps calling for no more than adapting techniques already in use for other purposes to the purpose of overseeing the implementation of parcel-scale stormwater practices that the developer has planned. The developer also suggested that for the builders to carry out these practices, the instructions would need to be very *rule-like*—“very simple, very clear cut, here’s what you have to do” (Porter & Ring 1, 53:26)—and the way drainage is to work on the parcel would need to be clearly noted on the plat.⁷

We know of one instance—the St. Francis subdivision in Cross Plains—at which parcel-scale practices have been planned by a developer where many sites went to independent builders. In this instance, “deed restrictions” were employed to mandate that, “...rain garden are constructed and maintained by the lot owners.” The developer reports that, “Compliance is running about 50%” (Heffron, personal communication).

Even if continuity can be maintained between plat-scale planning by a developer and parcel-scale activities, three substantial issues remain: homeowner attitudes (especially with regard to standing water), continuity in the maintenance of parcel-scale practices, and homeowners’ understanding of the functioning of an infiltration facility on their property.

Homeowner attitudes

As we turn to the subject of homeowners (including the subsequent section on “Homeowner understanding”), note that the only direct data we have on homeowners comes from focus groups with homeowners conducted in Maplewood, MN. Therefore, much of what follows is indirect evidence on homeowners, albeit reported to us by those who have daily

⁷For what is meant by “rule” here, see the section, “The problem is existing ordinances.”

interaction with them.

The feature of homeowner attitudes repeatedly mentioned was a dislike of standing water:

You have to kind of separate things like what you can do as part of a plat and what things should be done as part of individuals [individual parcels]. The ordinance focuses on the plat. Raingardens is [sic]... oversold for stormwater because, you know, from my experience is, the reason I don't like raingardens for stormwater management practice is...I used to get a lot of calls...Water would be sitting in the corner in their back yard and the homeowner, the housewife would have to keep their kids in...(Connors & Roa 1, 25:46).

The same interviewee claims that engineers hear the same thing:

Many engineers have told me over the years is their number one headache is a disgruntled housewife with water standing in her back yard (Connors & Roa 27:34).

This claim was supported both by an engineer we interviewed (Wardell 2, 4:58) and by the head of the Metropolitan Builders Association (MBA) (Moroney 1, 3:10). The engineer specifically noted that standing water has become such a concern that

...we have to look at individual drainage on lots...pretty close[ly] to make sure everything is draining properly and we don't have little pockets of water and bird baths in areas that don't drain, even to the extent of running storm sewer into back yards and things like that (Wardell 2, 5:16).

And as the head of the MBA noted:

...even if a developer goes in and leaves natural depressions in the soil...nine times out of ten the land owner will go in there and fill those so they got a nice level yard...And if there's any divot or depression if the builder doesn't get it the homeowner will either ask the builder to regrade it so that they get rid of those depressions or the homeowner themselves will fill those depressions up...The one thing no homeowner wants is water problems...in their yard or in their basement (Moroney 1, 3:06).

It is not clear that the concern he suggests here would necessarily apply to rain gardens; he seems to have in view depressions that one might call unintentional deviations from an otherwise well-graded yard. To the extent that rain gardens by their design and plantings appear to be intentional landscaping features, they might not be as readily objected to. There already exists research suggesting that departures from existing yard aesthetics are perceived as more acceptable to the extent that they appear to be intentionally cared for (Nassauer 1992; Nassauer 1993).

These claims do not, of course, allow us to quantify the exact extent to which homeowners would object to rain gardens, yet they should stand as a warning that attempts to get builders and developers to incorporate such gardens may come up against reluctance among

builders based upon their belief that homeowners will typically oppose them. Some of the regulating officials with whom we spoke also expressed reluctance about rain gardens, for reasons we take up in the next section.

We also found strong aversion to standing water among the homeowners who participated in our focus groups in Maplewood, MN. However, this aversion did not translate into opposition to rain gardens. To the contrary, homeowners who had had standing water on their properties were among those most willing to have rain gardens installed and found that the constructed gardens drained noticeably better than the depressions that had previously held standing water (see Appendix A). Yet some caution ought to be exercised in extrapolating from these results. The neighborhoods that received rain gardens were chosen because they suffered unusually poor drainage. It is not, therefore, certain that rain gardens (and whatever water might remain resident in them for however long) would be as well received by homeowners not subject to such poor initial drainage.

The continuity of maintenance

Apart from attitudes regarding standing water, concern was raised that homeowner turnover would undermine the maintenance of parcel-scale practices:

The other element that I also have experienced is things...targeted towards an individual lot in the platting phase where we put in a deed restriction for something that might be fine for the initial, for the first time homeowner, but then the second homeowner or the third homeowner that comes in—they're not as bound by those deed restrictions...You think in terms of five years out. First time, everybody is going to be aware of it; the landscaper is going to be required, the building inspector is going to be there to make sure everything is in. But five years out, guess what's going to disappear...So I think the rain gardens are a fine idea. Don't get me wrong. But they should not be in the same context as stormwater management. They should be incorporated as landscape design (Connors & Roa 1, 27:48).

A design consultant also acknowledged that maintaining continuity of understanding among homeowners is an “essential” principle of “ecological design” (Apfelbaum 1, 25:31). As he promotes the use of designs dependent on such continuity, he seems more optimistic than were Dane County officials. Difference of opinion in this regard underlines the need for future inquiry along these lines.

A similar concern was voiced by a developer who used to work as a municipal planner:

You run the risk of people encroaching. I've seen it with environmental corridor areas that have preservation restrictions on them. And then enforcing it after the fact is just a nightmare (Bielinski 1, 33:24).

However, this same developer mentioned that his firm routinely uses “covenants and restrictions” to set maximum driveway widths in their developments (Bielinski 2, 2:35), raising the question of whether the efficacy of such restrictions varies with the practice they would regulate.

Also bearing on the maintenance of parcel-scale practices may be those variables we found affecting the willingness of homeowners to accept rain gardens in Maplewood, MN. The city of Maplewood attempted to address poor drainage in several neighborhoods by retrofitting rain gardens along the street. The city made the installation of these gardens optional for homeowners. We found that three characteristics of residents may be relatively good predictors of who will opt for a garden: age, attitudes towards gardening, and whether a resident has a water problem on his or her property (see Appendix A, section III). The first two of these variables appeared to operate by affected a homeowner's ability (older residents less able) or desire (self-described gardeners more willing) to maintain a rain garden. We suspect these variables will likely operate in similar fashion on the maintenance of rain gardens elsewhere, though we hasten to add that the actual strength of these variables would have to be measured by survey techniques, as useful as the focus groups were in identifying them.

Homeowner understanding of infiltration facilities

From the Maplewood focus groups we also found that in spite of extensive educational efforts by the sponsoring municipality, residents regularly misunderstood basic functional properties of the rain gardens. Points of misunderstanding included the following: the operation of the overflow drains, the sizing of the gardens, residence time of water in the gardens, the systematic connectivity of the gardens, etc.

The operation of the overflow drains was clearly the point of greatest confusion. Gardeners and non-gardeners alike⁸ found the elevated drain pipes violated common sense; they expected a drain to be at the lowest point so the water would run out, as a bathtub or sink drain. The evident problem is that residents were interpreting the garden drains under a false analogy: the analogy is not with the main drain at the bottom of a sink or tub, but with the overflow drain located along the upper slope of a sink or tub. The presence and operation of such overflow drains in everyday living is likely overlooked by many, and so the false analogy to the main, bottom drain is quite understandable.

The functional misunderstanding was in some instances accompanied also by aesthetic dislike of the garden drains; being elevated, the drains are plainly visible and detract from the beauty of the gardens. The combination of misunderstanding and dislike of the drain poses the question of whether a different type of overflow drain design might address both problems at once: would it be possible to locate the drains flush with the ground, somewhere along the rising slope of the garden where it would serve its overflow function? The benefit of such a design would be not only to eliminate the drain as an eyesore, it would also put the drain in a position analogous to the customary position of an overflow drain in sinks or tubs, perhaps also making it easier for residents to correctly understand the drain's intended function. Whether by redesign or by more explicit and insistent explanation, the focus groups indicate that this misunderstanding ought to be addressed (see Appendix A, section VI, F).

⁸The focus groups consisted of a group of residents who had opted for a rain garden and a group that had not, hence "gardeners" and "non-gardeners".

Infiltration practices and the plat scale

Although we favor increasing parcel-scale infiltration, there are plat-scale practices that are promising in a number of regards, notably the use in more rural settings of conservation/cluster/compact subdivisions. There are, however, specific obstacles to this type of development, to which we now turn.

Getting approval for a conservation subdivision

Those who live in rural areas are said often to want to preserve a “rural atmosphere” (Bielinski 1, 23:25; *Rural Cluster Development Guide*, vii). Yet a common legal technique deployed to this end—setting high minimum lot sizes such as 5 acres—has proven unsatisfactory as a means of preserving “rural character,” and cluster development is offered as an alternate, often better technique (*Rural Cluster Development Guide*, vii). However, making use of clustering requires that concepts potentially elided in zoning ordinances be clearly distinguished: *density* and *lot size*. These concepts can stand in a relatively fixed mathematical relation ($density = 1/lot\ size$, that is, lots per acre = 1/acres per lot). But the whole idea of a conservation development is to introduce a third term, *open space*, which can leave densities unchanged while substantially reducing lot sizes. Mathematically expressed, $density = 1/lot\ size \times (1 - \% \text{ in open space})$. So if a municipality has only enacted a density ceiling, developers have the option of a conservation development in which lot sizes are traded off (down) against the creation of open space.

*...it was one of those situations where you knew you were **limited in the number of lots you could put on this property** [a density requirement]. So then you start looking at...O.K. we're trying to work with conservation subdivision design. This is an ideal location to apply that. This is one of those situations where we can apply it (Bielinski 2, 17:14, emphasis added).*

But in those communities that have enacted lot size requirements, clustered developments stand to violate zoning ordinances.⁹ It is in these communities that

We've tried to promote that in communities, particularly those that are, you know, tend to promote the straight 2 [or] 3-acre lot development. We've try to push that up if we can to 5 acres on average and then...encourage cluster development...[so] you could keep 60-70% open space (Biebel 24:55).

Furthermore, minimum lot sizes have sometimes become so identified as the means of preserving rural character that developers encounter stiff resistance to conservation developments. As one Milwaukee area developer who has been experimenting with conservation developments put it:

⁹ And when density and lot size stand in a simple reciprocal relation—that is, absent the idea of preserving open space—density and lot size requirements are near functional equivalents, such that municipalities might use these terms interchangeably.

...they don't want to see really small lots; they think that's bringing the city into their rural atmosphere. It's a tough attitude to break (Bielinski 1, 23:25).

“They” often includes not only municipal officials, but also neighboring property owners who fear small lot sizes are detrimental to the value of their properties and the character of the area (Bielinski 2, 53:03).

A general conclusion to be taken away from this discussion of lot sizes is that “the number of residential units, the density of residential units and the kind of residential units” is often a big “sticking point” between municipalities and developers. These are the “things that...[are] negotiated to the greatest extent” (Sullivan 1, 30:57), and stormwater issues are often caught up in the play of these issues, as will also be seen in the following section on “density bonuses”.

If developers can get past resistance to small lot sizes, they stand to save considerably on infrastructure costs with a conservation subdivision. Although it may not be clear that moving towards infiltration practices always lowers costs for developers (a topic discussed elsewhere in this report), it does appear that clustering houses on smaller lots takes a big bite out of infrastructure costs—even if road widths aren't narrowed or curb and gutter eliminated—because the lengths of road and sewer are so substantially reduced. As one developer remarked:

By trying to reduce the lot sizes down...you've reduced that amount of infrastructure we have to put in, which is a significant cost (Bielinski 2, 5:20; 9:25; also Moroney 1, 4:35).

The applicability of conservation developments to localities that put a premium on “rural character” may also minimize the need for storm sewers to the extent that swales are associated with such a rural aesthetic. However, not every community wishes to maintain a rural character, as one of our interviewees noted of Franklin in Milwaukee County:

the trend down there [in Franklin] is to want to change everything from roadside ditches, swales and culverts to curb and gutter and storm sewers...They're concerned about the fact that everybody just looks at us like we're the country bumpkins down here (Mick 2:45).

Even apart from such a negative association with swales, another interviewee suggested that shifting from dispersed rural development on large lots to clustered developments may reduce the aesthetic acceptability of swales by concentrating driveway culverts “every hundred feet...The tighter the development, the tougher it is to go with swales because...of the driveway culvert problems...” (Biebel 27:43, 38:53). The same interviewee made a more general claim that there may be a tradeoff between infiltration practices and reducing the land used in development:

If you push to hard, push those kind of [infiltration] practices and make them requirements,...one tendency is to push people out to those [larger] sites and increase... urban sprawl, as opposed to promoting compact, tight development around a central sewer and water system...It isn't so easy to put infiltration things into an area where

you're going to put 100 lots on 50 acres...Now there might be some combination [of] subsurface ways to do that too, but it's just harder to do it on densities that are the right thing to do in our region...(Biebel 38:00).

This tradeoff was also noted by a developer who has been readily trying infiltration practices:

...these practices can be applied in most subdivision design. It works a lot better if you can create open space areas, though (Bielinski 1, 32:40).

It should be noted that neither interviewee who indicated such a tradeoff saw such a tradeoff in conservation subdivisions, where the open space achieved by “tight development” in fact adds to opportunities for infiltration, as the second quotation clearly indicates.

Managing open space

Even where a municipal ordinance or conceptions of how to preserve “rural character” do not stand in the way of conservation developments, another challenge is setting up the organizational means by which open spaces are to be managed. The Milwaukee developer with whom we spoke felt that the size of his firm made this easier because the firm has good access to the legal expertise needed to set up such organization (Bielinski 2, 40:46):¹⁰

What prohibits other developers from doing this [?]....We may have the advantage that we are so large...We have a lot of resources...(Bielinski 2, 40:36).

This barrier—to the extent that it exists—will likely diminish with time as experience with conservation subdivisions becomes more widespread. There is, in short, organizational learning and codification that need to go on in this area. Some municipalities have already enacted conservation subdivision ordinances (Caledonia and New Berlin, WI). The Southeastern Wisconsin Regional Planning Commission has also provided municipalities with guidelines for creating such ordinances, including a chapter on managing open spaces (Commission 1996).

Density bonuses: the unused lever for conservation development?

The preceding section was written from the vantage point of assessing whether or not developers have the option to propose a conservation development under existing ordinances. But it is also useful to ask the question the other way around, from the vantage point of a municipality that may be interested in promoting conservation development: how might developers otherwise uninterested in conservation development be persuaded to consider it? The same answer came up in two separate interviews with representatives of the home building industry, density bonuses:

To encourage people to do something new, innovative...you need to provide some sort of

¹⁰The unusual expertise of Bielinski was independently noted by one of our other interviewees (Mick 29:43).

incentive...And the one incentive that we always point to is...give a small density bonus...And if there's some way to work that kind of flexibility into a system I think you'll find tremendously enhanced subdivisions. I think you'll find people bending over backwards trying to do the right thing (Moroney 1, 42:50).

The idea here is that if a developer builds according to what the community desires, the developer will be allowed to add lots in excess of what would have been allowed under existing density restrictions. And Moroney emphasizes that effective density bonuses only amount to marginal increases in density. One developer suggested that such bonuses are a powerful enough lever that they offer an alternative to mandatory ordinances. A community can use

...either [density] bonuses for what they really want you to do or like in Caledonia where they are making it mandatory to do conservation subdivisions (Bielinski 3, 55:50).

Density bonuses can be such an effective tool because they so affect a developer's bottom line (Bielinski 2, 6:33), to the point that if given a density bonus, "most developers then will say, ok, it's worth the additional time and effort" to comply with a municipality's requests (Moroney 1, 47:20). It is unclear how well density bonuses are being used as a tool of development policy. We did hear that the village of DeForest makes active use of such bonuses as a tool to protect open spaces or environmental corridors (Sullivan 1, 33:39). However, a recent attempt by officials in New Berlin to make use of density bonuses was rebuffed by residents with strong feelings against increasing densities, however marginal (Moroney 2, 1:40).

The maintenance of new approaches

Among the barriers facing new approaches are invariably those of long term maintenance: who will do it, how well will it be done, and how much will it cost? Of course, all practices pose such questions. But the forms of this question specific to infiltration practices came up regularly, and are a necessary part of any assessment of the barriers to such practices.

As a general matter, municipalities appear to differ in their willingness to take control of stormwater facilities. One developer asserted that:

I've found like at least in Sun Prairie...they want them; they want access to them, they want to be able to control them (Porter & Ring 2, 3:05).

Yet one of our investigators argues that municipalities become increasingly reluctant to take control:

I can speak from the village's point of view, having worked with the city of Middleton for 22 years. Ten years from now the village [of Sun Prairie] isn't going to want to do it because Middleton [has] absolutely realized that...having to maintain it becomes a tremendous burden on them...The cities aren't going to want in the long term, aren't going to want to maintain those things...(Porter & Ring 1, 56:22; also Porter & Ring 2, 3:32).

A developer we interviewed said of detention ponds:

Nine times out of ten the municipality does not want responsibility, does not want to pay for it (Bielinski 2, 33:36).

Although not all stormwater facilities are as much of a burden as detention/infiltration ponds, even the lowest maintenance items can require organized care. Take no-mow buffer zones, for instance. The village of DeForest has moved to using covenants/deed restrictions to maintain no-mow zones along waterways (Sullivan 1, 9:22). Here the “maintenance” costs will be in enforcement. Another instance—one requiring active maintenance rather than the passivity of a no-mow zone—is the use of a condominium association to oversee the maintenance of rain gardens on individual properties. This is being tried at the Waters Edge subdivision on Lake Wisconsin where although “[t]he rain gardens are maintained by the site owner[,] [t]he condo association has control and can assess the owner if the rain gardens are not maintained” (Heffron, personal communication). Such oversight authority is written into the by-laws of the association, which can’t be changed without town board approval. Such a mechanism keeps a degree of public accountability even when facilities are privately maintained. We were told this approach appealed to the town, providing the developer “a benefit in the approval processes” (Heffron 2, 0:18).¹¹

In another instance, a conservation subdivision has been organized in such a way that maintenance costs are born by the homeowners association. But because “...we didn’t trust, and even the municipality didn’t want to [en]trust...total control to the homeowners’ association,” the developer and municipality have located actual control over maintenance in a separate body, a “conservation trust” (Bielinski 2, 34:17; also Connors & Roa 1, 27:28, quoted earlier).

In neither the Heffron nor the Bielinski subdivisions was it clear exactly how fees were to be collected from homeowners, an organizational burden which another developer interviewed wanted to avoid (Porter & Ring 1, 49:52; Porter & Ring 2, 5-7). It may be possible for such fees to be incorporated into property taxes if administered under the auspices of a municipality, or as a separate fee as for a “utility district” (Sullivan 1, 25:46). Yet another developer has found municipalities prefer to avoid collecting such fees (Bielinski 2, 35:52). Our research at this point can only emphasize the importance of the issue. This issue comes up with sufficient regularity to suggest the need to inventory the legal means available and to monitor over time the relative effectiveness of various arrangements negotiated between municipalities and developers.

Developers stand ready to do what is asked of them

There is probably no point on which more of our interviewees agree: developers are not a

¹¹These remarks on management arrangements at Waters Edge were assembled from an interview and from an email many months later. From the latter communication it appears the management arrangements have been modified since our first interview. Although the above remarks take account of the modifications noted in the latter communication, that communication was not as detailed as the original interview, and so there may have been other changes to which we are not privy.

major barrier. Indeed, there is the occasional developer who becomes individually committed to alternative stormwater practices. But even developers lacking such zeal are usually ready to do what is asked of them in order to get a project done. Though they may not always be pleased by regulations, etc., they seem to accept having to play within the rules of the localities in which they build. Meeting those rules as quickly and efficiently as they can serves their bottom line. Delay is a developer's enemy. The point was made to us again and again by interviewees in various roles:

In the construction process, what is raising the price of property are not these innovative kind of things, it's bureaucracy, it's time (Heffron 1, 5:48).

This same developer emphasized the point by noting that he was willing to shoulder costs imposed by regulation if it meant getting a project done (Heffron 1, 12:40). As a DNR regulator claimed:

...[as] a practical matter, they're worried about time, and the sooner they can get the sign-off from me—basically, the sooner they get their permit coverage—the sooner they can break ground. So unless it's something that requires them to give up a lot they were going to develop or is something that they feel is cost-prohibitive, they are generally willing to do it (Moore 36:17; also Apfelbaum 1, 20:52).

The same interviewee later goes into illuminating detail as to why developers are so time-conscious:

Developers generally want to take the most direct route. They're on a time schedule...They've got so many months to recoup part of their investment because they've got to start paying off loans. They've got a very complex construction sequence that involves everything from obtaining right-of-ways to mass grading to getting utility contractors in there to selling individual lots...They really have their hands full. My hat goes off to them when it comes to orchestrating all this work. So the developer goes to a consultant and says, "I want you to do what you know works in the context of what will allow me to get my project built as fast as possible" (Moore 47:05; also Moroney 1, 30:38 and Jopke 1, 21:45).

Another interviewee points out that in "orchestrating" this "complex construction sequence," developers most often don't even get directly involved with the ordinances, but rather delegate compliance to their consulting engineers:

Let me give you an example of how [it] works. A developer comes into a city and he wants to build something. And he says to his consultant—because they all have consultants—make sure we follow the city ordinances. So the consultant goes to the ordinances and says, "Oh, this is what we have to do" (Bannerman 1, 16:53; confirmed also by Wardell 1, 8:32).

In addition to the cost of time as interest on money, an interviewee from the home building industry noted that delay is also financially risky because the “market could totally change” from the conditions under which a developer had deemed it prudent to undertake a project (Moroney 1, 27:46).

An engineer who consults for developers agrees that developers go along because they want to get along with their project:

The developer that’s out there—his engineer, attorneys, whatever it is—they’re going to look at the ordinances, and they want to get a project approved. And they’re going to, you know, follow what the ordinance says (Steiner 7:40).

These several quotations come from a variety of players in the development process: developers, regulators, consulting engineers—all seem to concur that as a general rule developers “will follow the path of least resistance” (Moroney 1, 22:42), which typically means compliance. However, one developer indicated that given the high value to developers of moving on with a project, ignoring regulations and shouldering the fines may just as well be the path of least resistance (Heffron 1, 13:40).¹² And of course, a developer may comply in a formal sense, but not in substance:

I also have to say...that every developer that’s worth his salt in Madison knows the same words and will pull them out and will use them just to get approval (Fix 15:20).

The threat of such merely formal compliance raises another issue about which we heard on several occasions: poor oversight and monitoring on the part of regulatory agencies invites a gap between formal and substantial compliance. For instance, it was suggested that NR 216 is poorly enforced for want of staff (Fix 20:10, 33:45; Moore 2, 1:08). And an “informal survey” of compliance conducted by two Dane County officials indicated that although stormwater plans and plan implementation are good, maintenance tends to fall short (Jopke 1, 34:42). A lack of monitoring was also noted as having the negative consequence of denying engineers the data necessary to calibrate and improve models used to design infiltration facilities. It was also noted that such improvements would make it easier for officials charged with reviewing proposed infiltration facilities to judge their adequacy (Bannerman 1, 20:26).

In connection with obtaining a chapter 30 permit, one developer noted the value of showing “that you’re actually going above and beyond trying to protect some of these areas” (Bielinski 3, 11:36). One of our interviewees on the regulatory side also noted a willingness among developers to go beyond requirements in order to show good faith to regulators (Fix 18:55). Although it seems unlikely that such super-compliance is the norm, it is at least consistent with the general conclusion here that developers are more concerned to get through a permitting process than to oppose it.

¹²On the importance of trust in determining which way this will go, see the subsection on “education and trust.”

The costs of alternative approaches

There is little dispute that the readiness with which infiltration practices will be adopted depends partly on the costs of such practices relative to more traditional techniques. There is, however, some uncertainty as to what the relative costs are.

One of our most practically successful interviewees (in the sense of regularly achieving infiltration practices in a successful consulting business) claims that the relative costs are highly in favor of practices that reduce impervious areas and reduce infrastructure investments:

So any time we can pop in with an economic opportunity and reduce the total costs of the project...On many projects it's been in the 5 to 18% range. Not just infiltration systems but a whole host of other things that we've done. That is a big kicker; that's 5-18% off the, you know, of increased net, potentially, with these people. So money talks. We save them money. That's a big barrier (Apfelbaum 1, 6:18).

There does seem to be some agreement among developers that swales are definitely cheaper to install than storm sewers (Moroney 1, 4:31; Wardell 2, 2:15) and that infiltration can save developers on engineering costs (Moroney 1, 23:38).¹³ And as noted above in the section on plot-scale infiltration options, conservation developments substantially reduce infrastructure by clustering houses together. But as our interviewee in the last quotation himself notes, the large savings he indicates do not derive solely from infiltration practices.

County regulators also felt that infiltration practices were prohibitive neither in their costs nor their complexity:

Many of these practices that we are implementing, you are going to see they are no[t] expensive. They are very good, and they can do it eas[ily]...It's common sense and rocks (Connors & Roa 2, 10:29 and 2, 59:58; also Steiner 39:03).

A DNR official concurred in this assessment in reference to the specific practice of deep tilling to break up compacted soils (Moore 36:42).

In a pithy summary statement of the feasibility of infiltration practices being promoted by the county land conservation department:

...And you will see everything that we do in the county is about rock. And you will see that there is no concrete in anything that we are doing (Connors & Roa 2, 59:58).

A developer who has begun to use infiltration techniques believes they *are* more expensive, but only marginally so, posing no real practical barrier, perhaps even an eventual benefit:

It costs more, but it's not the...when you look at the cost break-down of the entire process, this is not a make or break...it's not that critical. I really think it's going to come out that

¹³However, one engineering firm warned of increasing engineering fees in response to new legal requirements for infiltration (Wardell 2, 0:05).

we are going to see benefits from it, that it will actually make us money (Heffron 1, 5:21; also Jopke 1, 13:07).

A private consulting engineer we interviewed also indicated that his firm was considering raising its fees to help developers meet some of the new requirements coming on line in the new Dane County ordinance (Wardell 2, 0:05).

One cost-related barrier that came up on several occasions was a refusal by approving authorities to allow credit for infiltration practices in stormwater budgets. A developer who brought up the issue was denied credit by an engineer who was “not comfortable” with rain gardens (Heffron 1, 46:49). An engineer who was also denied credit for rain gardens attributed the denial to a lack of confidence that homeowners would maintain them (Bannerman 1, 53:44). Past failures of infiltration practices also offer reason for such refusal:

The history with infiltration ponds is not good in terms of maintenance, in terms of functionality after 2 to 5 years down the road (Fix 9:46; also Connors & Roa 1, 3:30).¹⁴

Questions about the reliability of infiltration practices also presented a liability concern to an engineering firm we contacted (Wardell 1, 15:51).¹⁵ To the extent that credit for infiltration is refused, the economic benefits of such practices will not be realized, no matter their relative economy.

Even if infiltration is credited in stormwater budgets, developers may not be allowed to do away with all the infrastructure they might. A good example of this is the Cross Plains development where curbs and gutters were required by the municipality in spite of the development’s unusual emphasis on infiltration practices (Jopke 2, 21:45). There can be several reasons for the persistence of such infrastructure, such as the role of curbs in maintaining the road’s edge, facilitating street sweeping and snow removal (Bannerman 1, 25:39), or in meeting an urban aesthetic, as noted above in reference to the shift to curb and gutter in Franklin.

One element of costs is, of course, how much a developer can get for a property. Because our data collection occurred when most projects here discussed were still in the planning or construction phase, we do not know how the market has responded to these developments. However, one developer saw promising signs:

One thing I can tell you—we’ve gotten feedback from potential buyers...[who are] very excited (Bielinski 2, 32:59).

The importance of the question of costs certainly warrants further inquiry, especially in

¹⁴Note especially the published works on the topic (Schueler and Holland 2000: articles 101 and 102).

¹⁵Though this same engineer later indicated that liability concerns were more a matter of his firm’s “minimum experience” with infiltration practices than any history of failures with such practices (Wardell 1, 52:14).

light of the fact that these costs are probably in flux as infiltration practices are learned and refined.

The lack of expertise in the design community

Some members of our research team have been concerned that a barrier lies in the design or engineering communities. Certainly the head of one of the leading ecological design firms sees it this way:

The biggest barrier to getting these projects done is the inability of the design community to recognize opportunity and to present opportunity; to flip the barriers over and create opportunities with the barriers...(Apfelbaum 1, 8:07).

This concern is voiced from the perspective that the design community ought to or can lead the way to a greater use of infiltration practices. As welcome as such initiative would be, many stormwater engineers are hired by developers with the understanding that their job is to help the developer comply with ordinances in a timely and cost-effective manner, not leaving much room for bold initiative. Yet Dane County officials claim that most consultants have at least been exposed to infiltration practices:

There's a learning curve...There's a certain uneasiness, but most all the consultants within Dane County—the design community—have had some projects that have come under this approach (Connor & Roa 50:05).

They also claim that engineers readily learn new practices once the demand is placed upon them:

You can have a countryside engineer or big city engineer, they learn the same way (Connors & Roa 2, 9:25).

Yet as one engineer indicated, those demands just aren't made that often, at least not yet (Wardell 1, 10:17). However, this same engineer (who says his firm had not yet done any infiltration practices) knew that the county Land Conservation Department was "up to speed" on such practices and could help his firm become so (Wardell 1, 14:25). A developer who was asked about the readiness of his engineers to design infiltration facilities responded that, "Infiltration basins aren't a new concept. Some communities actually require those," naming the city of Oconomowoc as an instance (Bielinski 1, 38:13). And when asked about engineering firms more generally, he again affirmed:

I'm sure that most of them are capable of being able to design or understand what communities want or understand the concepts of these different stormwater treatment systems and to be able to apply those (Bielinski 3, 49:08).

Yet opinion clearly differs on this question. One engineer we interviewed argued that the "established traditions" of "civil engineers" make stormwater a "waste product" (Bannerman 1, 27:23). Another engineer at the DNR who reviews stormwater plans believes that, "We have a lot

of traditional civil engineers out there...[who] don't have the knowledge" when it comes to infiltration practices (Moore 1, 49:58). This latter engineer was commenting on the readiness of a consultant to suggest infiltration practices to a developer expressing interests in this direction. Similarly, the executive director of the Milwaukee Metropolitan Sewerage District—himself an engineer—has found enough “reluctance” to MMSD’s new infiltration rules to warrant creating demonstration projects. And in comparison to his prior experience around Chicago, he finds the engineering community around Milwaukee behind in these practices. Yet like the Dane County officials, he sees the issue as a need for greater exposure to these ideas (Shafer 2, 2:10). Furthermore, he expects that Milwaukee area engineering firms will likely increase their hiring of expertise in “environmentally sensitive flood management” in light of the 200 million dollars MMSD has budgeted to promote such management (Shafer 2, 12:48).

Barriers at the municipal level

Municipal engineers and staff

As the next section details, municipal ordinances appear to be one of the key barriers to infiltration practices. Yet now that Dane County has a new county-wide ordinance promoting infiltration practices, concern has shifted to whether the municipalities have personnel prepared to carry it through:

Right now we've got basically two people in our office...doing the planning. When you expand that to 61 municipalities, it's just an issue of how are we going to translate some of their knowledge...to the municipal staff, because we've got 20-some cities and villages and we're not going to do their work (Connors & Roa 2, 2:26).

So although county officials believe that engineers—when working in the capacity of consultant to a developer—are able to *respond* to specific regulatory requests made upon them, learning as they go, they seem less sanguine that the municipal staff (among whom are engineers) are prepared to *direct* a transition to infiltration practices. This distinction between *following* and *leading* a transition toward infiltration practices appears to offer a more nuanced sense of where the barrier is located within the engineering community.¹⁶ Because county officials see a more substantial barrier in *leading*, they anticipate the need for organized training sessions for municipal staff to prepare them for administering the new ordinance (Connors & Roa 2, 4:10). The doubt expressed by an engineer at the DNR that many engineers “don't have the knowledge” when it comes to infiltration was also speaking to the willingness of engineers to *lead* the transition (Moore 1, 48:58). A developer we interviewed indicated that municipal engineers—those who might lead a shift in practices—are the ones who most frustrate his attempts to move away from traditional detention techniques. He notes the case of Prairie du Sac where the municipal engineer has regularly insisted on detention basins in an area with soils exceptionally well suited to infiltration (Heffron 1, 2:39). Thus the disposition of municipal engineers is not only crucial

¹⁶For the distinction between *following* and *leading*, one could substitute a distinction in terms of the regulatory approval process, between those *seeking* regulatory approval and those *giving* it. Engineers are working on both sides of this process.

in the sense that they are in a position to lead a transition, but also in that they can thwart what initiative may come from a developer or a developer's consultant.

One developer (who previously worked as a municipal planner) seemed to suggest that among those in a position to lead such a transition, municipal engineers were more in need of additional training than planners:

...I'd say 75% of the communities we deal with do have...planning staff that would...understand these principles..., [though] some of these communities don't even have planners... Typically when you come into a community and you are looking to develop the land, you start with the planner...because you need to get through that planning process before you start dealing with the engineering department. [In] other communities, it's the engineer that you start with, and they are basically the planner and they don't have this background. So that's where it can cause problems (Bielinski 2, 43:29).

The head of the Metropolitan Builders Association agreed that the persistence of wide streets should be blamed on municipal engineers, not on either planners or developers:

We've been on board trying to narrow street widths...because that helps greatly with design flexibility and the ability to infiltrate stormwater runoff...There are a lot of things that make a lot of sense, but what you are going to find is your biggest impediment often is a municipality and their, not necessarily their planning staff, but most of the time it's their city engineer...(Moroney 1, 8:57).

A private consultant had a somewhat different take on where to locate the barrier here at issue. Rather than point to a single group, he spoke of a larger "design community" that included engineers, architects, landscape architects and urban planner. The barrier he saw—a barrier among the members of this larger community—was "the design community's inability to transcend, to go between disciplines" (Apfelbaum 1, 9:52).

One developer seemed to suggest that municipal engineers are a substantial barrier in part because they are risk-averse:

The practical problem is you put this man, he is the hired expert for the village, they're paying him...to approve this plan. And he knows there is not risk staying, coloring totally in the lines...He would say, we'll allow you to do the rain garden. I think it's a nice idea, but we will not loosen any of the other [requirements]...you can't make your detention ponds smaller even though your model says [we could]...because I'm just not comfortable with that (Heffron 1, 46:49).

This developer did not indicate whether the "lines" the engineer was averse to crossing were his own professional standards or the local ordinance to which he is responsible. It appears that both are involved. One of our interviewees who has much practical experience in overcoming barriers to infiltration indicates that the attitudes of municipal staff are themselves critical:

You have to start with the [municipal] staff involved, you know, whether they're the public works director, the city engineer. The things that are happening...are happening because those staff are on board (Bannerman 1, 7:05).¹⁷

Yet he goes on immediately to argue that “The hurdle that’s probably the most difficult one is changing the ordinances” (Bannerman 1, 7:40). It is to such ordinances that we now turn.

The problem is existing *municipal* ordinances

As we have already seen with lot size requirements standing in the way of conservation subdivisions, municipal ordinances are arguably the most regular and persistent barrier to infiltration practices. As one engineer who consults both for developer clients and municipalities put it:

[W]e've got to start with the ordinances (Steiner 9:47).

More specifically, he notes:

Well, there are ordinances—and I can point to them today—that say that, gee, we want the water to flow as fast as it can to wherever it's got to go. Which was the old thinking about, maybe in the '50s, you know, the idea about stormwater management was kind of like computer monitors; they can't be too big, you know, the culverts can't be too big. Just make them as big as you can (Steiner 7:51).

It is easy to see how such an ordinance might make an engineer averse to new practices. There are also ordinances—like the recent stormwater ordinance in the village of DeForest—that explicitly encourage experimentation with new practices, an approach that might address the risk-aversion of a municipal engineer (Sullivan 1, 5:22). However, one consulting engineer indicated that municipal ordinances generally lack flexibility:

We work all over Dane County and just about every community we go to, the ordinances are very similar. It's like somebody took Madison's ordinance and said, “Well, we need an ordinance, so let's follow Madison (Wardell 1, 32:45; on “flexibility,” see Wardell 1, 25:30).

It bears emphasizing that in our interviews it was not ordinances in general that pose barriers, but most often *municipal* ordinances, specifically zoning ordinances. One developer argued that it's "not so hard to get the concepts through people like SEWRPAC, MMSD or the DNR..." (Bielinski 2, 53:55). Although municipal ordinances are most often the ones indicated by our

¹⁷This assessment of the situation—that change really sets in once municipal “staff are on board”—was echoed by the leader of a design firm who has found that, “the projects that are probably the most productive...are the projects where we represent the community,” which is to say when his firm takes on roles typically played by municipal staff (Apfelbaum 1, 28:42).

interviewees as standing in the way of infiltration, the state's NR 151 also came in for criticism:

[In] NR 151 they had an infiltration management standard ...[B]ased on the criteria for implementing that standard in Dane County, very little area in Dane county could we even consider [for] doing infiltration...To me that's a lack of understanding at the state level (Connors & Roa 1, 4:35).

NR 151 was criticized not only for excluding “over 80%” of Dane county from infiltration, but also for setting up too detailed and rigid a method for determining how much infiltration should be expected. Instead of such a pre-set method, it was suggested that regulations should “...lay[] out...some general concepts” (Connors & Roa 1, 6:18).

Putting aside for the moment the cogency of this criticism of NR 151, it raises a general issue of legislative drafting.¹⁸ There is a school of thought among American legal scholars that a distinction should be drawn between *rules* and *standards* in the writing of laws, the former indicating a precise way of doing something, the latter indicating a desired consequence, without specifying the exact course of action to achieve it. This school of thought is careful *not* to suggest that laws always be written either as rules or standards, but rather points out that the appropriateness of one or the other depends on the specific subject matter. Our interviews seem to indicate that when it comes to legal requirements for infiltration, standards are more useful legal tools than rules:

Attorneys somehow feel—...[the attorneys who] write most of these ordinances—that they can cookie-cutter this stuff, that they can write an ordinance and you know we'll just do the same thing every time and everything will be perfect. Well, that works ok with some things, but it does not work with storm water because the circumstances vary so much (Steiner 9:19; also Apfelbaum 1, 59:32 and especially Apfelbaum 2, 3:25).

As Steiner indicates, this need for standards seems to derive from the high degree of site-customization required to determine, first, whether infiltration is desirable in a specific context and, second, how to make infiltration work in those contexts where it is desirable (a good instance of customizing infiltration to the site is the infiltration achieved in Middleton Hills, Connors & Roa 1, 29:16). One interviewee saw it as nearly impossible to fix a set of rules to cover the variation on the landscape:

I challenge anyone to come up with a design that's going to work on every site (Moore 51:12).

Although the exact terms of his distinction (*standards* versus *rules*) was chosen by the

¹⁸Although remarks directed at NR 151 are here used to bring up the following discussion of *standards* versus *rules*, municipal ordinances are certainly subject to this criticism (e.g. Wardell 1, 25:30).

authors of this report,¹⁹ substantially the same distinction was made on several occasions by our interviewees, albeit using different terms. For instance, one interviewee distinguished between a “policy approach” (according to which “every one-acre site of new development should do certain things”) and a “planning approach” whereby stormwater practices are tailored to a “logical subwatershed,” allowing officials to “relate things directly to the needs of the surface water system” (Biebel 10:54). Another interviewee made use of the distinction to describe how he interacts with a developer:

So the approach I take is, I say, based on my experience, here’s what I recommend you do here. If you have another idea that’ll get to the same objective, that’s fine (Moore 36:05).

Developers apparently appreciate this willingness to consider multiple ways to meet the same standard or objective; a developer we interviewed objected precisely to an municipal engineer who was too rule-based in his approach, insisting on detention basins even when soils conduced to infiltration (Heffron 1, 2:39). And a DNR regulator (different from the one just quoted, and with whom—in contrast to the municipal engineer—the developer has established a constructive working relationship) described his regulatory approach again in terms of setting *standards* of compliance:

Let the decisions lie with the contractor and just [let them] know there’s consequences if you don’t do it right...You solve the problem the way you want to (Heffron 1, 21:04).

We again heard the complaint of a rule-bound style of regulation from the head of the Metropolitan Builders Association, who complained that the “least qualified” DNR staff are those who “want to...go strictly by the book” (Moroney 1, 20:51).

Finally, an engineering consultant suggested that landscape variation is so substantial that some locations conduce to managing water quality, others to managing quantity, and that regulations should permit a trade-off between the two so as to realize the maximum benefits on a given site (Steiner 9:58).

The recent stormwater regulation passed by the Milwaukee Metropolitan Sewerage District blends standards and rules. It sets a tight runoff *standard*, without strict specification of means. The regulation does include a prioritized list of practices, but leaves to the engineers to “select[] the runoff management techniques appropriate for a particular development” (MMSD Chapter 13, section 11).

The chemistry of success

As the earlier sections of this report indicate, there are indeed a variety of challenges to increasing infiltration practices. Yet infiltration is happening. In fact, some of our interviewees felt there were no barriers: “I don’t believe there is any barrier, because we are doing it”

¹⁹And these exact terms were chosen to place the discussion here in relation to the strain of American legal thought on the subject mentioned above.

(Connors & Roa 2, 9:21), and this section attempts to summarize six conditions that appear most conducive to getting infiltration practices on the ground.

PUDs

Whether or not an ordinance provides flexibility of the above-described sort, in most municipalities there is the option of a planned unit development (PUD). In fact the need for flexibility relative to existing ordinances is well illustrated by the fact that many of the projects with infiltration that we have encountered have been achieved under the PUD option. And as the head of a thriving ecological design firm asserts:

The most successful projects we've worked on have thrown the ordinances out right from the beginning... We do a lot of this work under PUD ordinances (Apfelbaum 1, 15:48 and 57:10).

Another engineer who specializes in infiltration projects noted that “the two demonstration sites I’m doing now are essentially PUDs” (Bannerman 1, 17:46). And when a developer was asked, “How important a door is PUD into alternative forms of development,” he responded, “Without it, it would be very difficult” (Bielinski 1, 54:40).

The fact that many of the developments incorporating infiltration practices that we have encountered are pursued not under existing zoning rules but under PUD status might seem cause for some despair; PUDs consume time, money and energy from all parties involved. As the head of the Metropolitan Builders Association noted:

PUDs are seen as a big pain in the butt, unless you really know your way through the system. And a lot of communities—it's on their books but they don't really like PUDs (Moroney 1, 45:12).

Yet municipalities that have approved projects with newer stormwater practices under PUDs may use that experience to revise zoning ordinances so as to promote practices first considered only under the PUD. One instance of this is in Caledonia, where the municipality was working on a new ordinance to promote conservation development concurrently with considering a conservation subdivision under PUD status (Bielinski 1, 8:40). In this specific instance, legal expertise hired by the developer was even actively involved in working out the new legislation:

We've had a couple of [our] attorneys helping us go to these Caledonia meetings when we were dealing with the ordinance and helping them actually draft the ordinance...by offering people to do the work for them (Bielinski 2, 41:27).

Similarly, a municipal official from DeForest indicated that his village is using a PUD to experiment with new practices (Sullivan 1, 7:54). So PUDs apparently are serving not only as an escape from existing ordinances but also as a route to refashioning such ordinances.

Sensitive areas: wetlands, environmental corridors, cold water streams, etc.

A recurring theme was the role of sensitive or high-value resources in providing impetus

for consideration of alternative stormwater practices. Developments that came up during our interviews where infiltration is being used were often sites that had such resources (ABS, St. Francis, Waters Edge, Prairie Glenn, etc). As a municipal official from DeForest stated:

So you see a few good things happening, especially in and around the river systems (Sullivan 1, 9:28).

Sensitive areas not only give reason to consider infiltration practices, they often bring into play additional legal requirements, particularly those of the Department of Natural Resources (e.g. chapter 30 permits, NR 151, NR 216, etc.). Protecting such sensitive areas may provide an occasion for revisiting and revising municipal ordinances, parallel to the occasion for experimentation noted above with respect to PUDs.

While acknowledging the catalytic role of sensitive areas, one consultant saw a barrier in this dynamic:

It used to be that it was the projects adjacent to or within recognized sensitive environmental areas that would get us right to that discussion [of ecological planning]. So one of the barriers is basically letting people know that every piece of property is connected to an environmentally sensitive area...(Apfelbaum 1, 47:01).

The right tools

When a developer was presented with a stormwater management plan including infiltration practices with which he did not have much familiarity, his response was to ask whether there were practical guidelines available for his engineers (Porter & Ring 1, 29:27). This need for guidelines has in fact been recognized (Fix 32:06) and is being filled, partly by the efforts of members of our research team. Note for instance the pamphlet on rain gardens that has been produced by the DNR and UW Extension, as well as the manual on erosion control and stormwater management produced by the Dane County Land Conservation for meeting the new county ordinance.²⁰ The Milwaukee Metropolitan Sewerage District has also set up a variety of demonstration projects, such as “green roof” infiltration (Shafer 2, 3:15).

Officials at the Dane County Land Conservation Department argue that another key tool for promoting infiltration is what they call a “probable permeability map,” a 3-dimensional mapping that greatly improves on surface soils maps for determining where infiltration is possible (Connors & Roa 1, 10:05). It appears that such a permeability map is a novel tool, not yet available in other counties of the state. When a developer in the Milwaukee area wants soils information beyond the “soil service maps,” his firm has to hire a “geo-technical engineering firm” to do on-site soil borings (Bielinski 3, 56:31). The executive direction of the Milwaukee Metropolitan Sewerage District was not even aware of such a tool, in spite of his interests in infiltration:

I hadn't heard about a map like you had talked about that Dane County has that shows

²⁰See <http://www.co.dane.wi.us/commissions/lakes/stormwatermanual.shtml>.

[probable permeability] (Shafer 1, 2:16).

The availability of this tool in Dane County was attributed to the unusual synergy of the county, DNR and the University (Connors & Roa 1, 33:30) along with a fortuitous decision:

a decision was made at the county maybe 8 years ago [to generate the probable permeability map]...what we always forget [is that] as a county we have certainly the best tools around, more than anybody else...but that is what happened in a decision that was made eight years ago, and had we not made that decision—[that] technological decision, [that] advance—we [would] be I think like every county (Connors & Roa 1, 30:50).

The unusual capacities of Dane County were independently noted by a DNR official with multi-county responsibilities :

Dane County is in this part of the state in my view hands down the most progressive...If you go to other counties...you're going to find that the county LCDs are far less equipped...(Moore 8:56; also Fix 58:56).

Another recently created tool is a mapping of the county's cold water resources which facilitates getting resource issues into the planning process early:

Now we are getting these kind of factors [e.g. cold water resources], natural resource factors into the decision making process at the idea stage of a development, instead of after the fact when they got a contract, they got the streets laid out, they got, you know, all the bidding specs...that is very, very frustrating (Connors & Roa 1, 58:56).

In addition to this new tool, it was suggested that an old tool needs to be recalibrated; hydrology models (such as TR 55) need to be recalibrated to take into consideration soil compaction during development

That's the problem that is happening all over the country; the hydrology has been used wrong...And we're making everybody accountable for that...You have two alternatives: you bump the curve [?] number or you put and rake the soil back again to a normal condition[] (Connors & Roa 1, 23:15).

The problem of soil compaction during development was independently emphasized by another of our interviewees (Mick 54:29).

Timely planning

The planning and approval process for developers is complex, and it should not be assumed that they organize their planning in the most efficient manner. Officials who are successfully getting infiltration practices on the ground have found it useful to get stormwater considerations into a developer's planning process early on:

If you can lay out some ideas in their formative stage... If you look at a decision making process for what a developer has to do, many times erosion and storm water is the second to the last thing in that matrix of decision making processes, and it's just to get the permit...What we are doing is, this is what you need to meet and so we can get those decisions made earlier in the planning phase... And that's huge. That is huge (Connors & Roa 1, 48:32; also Steiner 39:06).

The need to get consideration of infiltration practices into the planning process early is shared by members of our research team (Porter & Ring 1, 38:36). The idea of early consideration of infiltration is consistent with another point of this report, namely, that infiltration may best be promoted through standards, where a “standard” means an objective that guide the planning of a development, where such guidance can only operate if the objective is held in mind from the outset of the development process. Holding the objective of infiltration in mind practically means posing a question:

We don't want to paint this as...something that's complex. It's really not. A lot of it is common sense. A lot of it is a case of simply asking that fundamental question, “How can we get this water to soak into the ground instead of sheeting off the surface?”... We are asking them to design these developments with storm water in mind...(Moore 1, 44:39).

Because the planning and approval process is potentially costly and frustrating, getting stormwater considerations in up front may save the developer the time he values and improve the regulatory relationship:

...rather than after the fact, after the developer has payed his engineer to do a certain thing to meet certain requirements. What is happening is [we are] getting the ideas in in the idea and planning stage (Connors & Roa 1, 14:31; also 1, 58:56, quoted above).

The head of the Milwaukee Metropolitan Builders Association also affirmed the importance of timely planning, of getting “water issues right up front, right in the drafting stages” of a development plan. Such timely planning, he argued, increases the efficiency both of regulators and developers. He noted that such timely planning has been achieved in Waukesha County (Moroney 1, 37:41).

Education and Trust

As one municipal official indicated, stormwater management plans are the result of a “back and forth” iterative negotiation between a developer and zoning authorities (Sullivan 1, 29:22). A number of our interviewees emphasized the importance of trust in this negotiation process, especially as it promotes an openness to mutual education:

There are some real barriers that are sometimes very difficult to flip over. And the only way we do it is primarily through a process of building trust with the developer. It's basic human relationships...So there's a barrier that only comes [down] with spending

time and investing in the relationship and letting people kick the tires and see real projects that have worked (Apfelbaum 1, 8:24; also 2, 29:02).

The building of trust was also emphasized by county regulators, who feel that over the last few years the “suspicion of government” has lessened as developers have found that regulators are treating them with respect, helping them solve problems, and providing training to help meet regulations. Also noted was that developers have become more accepting of on-site inspections:

One of the things also: the acceptance of the inspector. That is another barrier that has fallen also because they used to resent the inspector a little bit. Right now...they try to comply...Before they ignore[] it, [saying,] “Fine me again” (Connors and Roa 2, 11:16).

The county regulators also indicated in some detail several ways in which they have built trust. For instance:

I will tell you...why we are being successful at the county level...The standard practice is that...we compromise to a better solution...We compromise, one or another way...One of the other things is that...[we] have learned to listen. That’s a very important thing...That’s one of the biggest things I have learned also, to listen (Connors & Roa 1, 9:05).

From the other side of the regulator-developer relationship we heard much the same thing:

We work through several different issues. We just got to the point where he knew I would do or try to do what I said I was going to do, and vice versa...I mean he [a DNR inspector] was always welcome on our site (Heffron 1, 20:22).

Perhaps the strongest testimony to the effectiveness of established trust is the fact that infiltration practices that Dane County Land Conservation officials have been getting on the ground have not (until recently) been required by law. Through the quality of the relationships established with those they regulate, they have been able to achieve infiltration out in front of statutory requirements. Trust has been an ingredient of success not only in the relation between regulator and developer, but also among agencies in Dane County working on stormwater issues (Connors & Roa 1, 33:30). One interviewee indicated the outstanding accomplishment of the Dane County Land Conservation Department in this regard:

The Land Conservation Department in Dane County is widely respected both by municipalities—even though they often times are at odds with them—and by the rural sector, the towns. And they have been doing things here that would be unthinkable in Waukesha county or unthinkable in Clarke County for a land conservation department (Fix 58:57).

A developer also felt that the quality of his firm’s relation with a municipality facilitated

approval of a conservation subdivision:

Communities are starting to want to make the change. Why don't we go and be in front of the game and let's try and present these and show them that it can work and kind of build up that relationship...Sometimes it's a little harder to convince municipalities to do these types of projects [conservation subdivisions]. And that's where it's more of an education process (Bielinski 1, 18:00; 23:56).

This interviewee argued that one of the points on which municipalities require some education is that smaller lots can be consistent with maintaining rural character, even a leading means of doing so, the specifics of which were discussed above in the section on infiltration at the plat level. This same developer notes having been approached by other developers for advice on how to get municipalities to “buy into” the concept of a conservation subdivision (Bielinski 2, 52:30).

Ordinances

During the period of our study, the two counties in which our primary data collection occurred both passed new stormwater regulations.²¹ There are differences between the regulations that point up the varied purposes infiltration can serve. In Milwaukee County (and in portions of surrounding counties within the Metropolitan Milwaukee Sewerage District) the new legal requirements serve customary stormwater management goals of flood avoidance, stating as the primary purpose of the new rule:

to reduce the unsafe conditions, property damage, economic losses, and adverse health effects caused by flooding (13.01(1)).²²

In the Dane County ordinance, by contrast, flood control comes in fifth on a list of reasons topped by concern for water quality and the maintenance of surface water amenities (lakes, rivers and wetlands). These differences in formal legal emphasis underline what our interviews revealed informally: infiltration serves different (albeit somewhat overlapping) sets of goals in these two areas. New in both of these legal rules is a standardization of policy at a larger geographical scale. Although they do not wipe out municipal ordinances, they set new minimums and guidelines to which municipalities are legally obligated to adjust their ordinances. Given the various barriers posed by municipal ordinances to infiltration documented throughout this report, it is difficult to see how this higher-level impetus towards infiltration is anything but salutary.

Although the passage of these new regulations has in our interviews only been spoken of in positive terms, one county regulator emphasized the importance of the relationships built in

²¹In Dane County, the new law is a county ordinance, whereas in the Milwaukee area, the new law is an administrative rule promulgated by the Milwaukee Metropolitan Sewerage District under delegated rule-making authority.

²²To see these rules, consult <http://www.mmsd.com/stormwaterweb/PDFs/mmsdc13.pdf>.

the regulatory process by relativizing the importance of formal regulations:

Rules come and go. We need to change how we fundamentally do business (Connors and Roa 2, 13:07).

This statement came from those county officials who have been getting infiltration practices on the ground prior to any formal legal requirement for such practices, as was noted earlier. These are also the officials who not only emphasize trust-building themselves, but whose relations with developers and other agencies are widely praised. So their statement bears the test of practice. Recall also that these same officials saw the passage of the new county ordinance as hardly working automatically, rather calling for new training across those municipalities whose staff will be on the front line of implementing the new Dane County ordinance. Broadly speaking, our results show that *both* formal laws and those who implement them can be the locus of barriers to infiltration, especially on the municipal level.

As was noted above, several municipalities have also produced ordinances promoting infiltration. One developer indicated that his firm has begun experimenting with conservation developments out of a sense of a growing "...interest by municipalities...to see something different, to be more innovative" (Bielinski 1, 8:18, 17:52). This statement is in line with the observation above that developers are ready to do what is asked of them, ready enough even to anticipate in which direction they think municipalities are going.

Notes on basic concepts

In situations of change like the one we are here investigating, shifts in discourse, in basic concepts are sometimes central. Although we did not assess the "discourse" of stormwater management in any systematic way, on several occasions our interviewees insisted on clarifying distinctions that they seemed to feel were being generally overlooked, and that these distinctions—if more broadly appreciated—would facilitate a reorientation of stormwater management.

We have already noted in the discussion of plot-scale infiltration two concepts easily elided, *density* and *lot size*. We have nothing more to add on that subject here. Two additional distinctions have not, however, come in for any discussion, distinctions between *peak flows* and *total volumes* of stormwater runoff, and between *infiltration* and *groundwater recharge*.

The importance of distinguishing between *peak flows* and *total volumes* was brought to our attention by an engineer, who seems to feel that those involved in managing stormwater have been trained to think mainly in terms of peak flows, this being the quantity on which management attention is focused. So exclusive is the focus on peak flows that the term "runoff" is most often used as its synonym, even though "runoff" is a term general enough to mean flows or volumes. As this engineer pointed out, "runoff" is so closely identified with the common focus of attention (peak flows, that is) that when the subject actually turns to total volumes (perhaps spoken of as "runoff"), people reason as if the subject were still peak flows, coming to misplaced conclusions about what is happening:

Now here's the myth...We've fooled somebody into thinking no more water is going to run off (Steiner 17:40).

His basic point is that attention needs to be drawn back to total volumes and that the habit of thinking of “runoff” only as if it entailed peak flows is a barrier to this shift in attention. In support of Steiner’s concern, we encountered one municipal official thoroughly involved with stormwater management who, nonetheless, balked when asked to state whether his municipality’s ordinance regulated peak flow or total volumes:

Interviewee: *What they have to design for—when they put in detention basins—is for the runoff not to exceed what it would have been pre-construction period.*

Interviewer: *By that do you mean the peak flow or the total volume of water running across the surface. That is, does that mean that the same amount of water is supposed to be infiltrating?*

Interviewee: *I can’t answer that. I’d have to get you the details on that. I can’t recall exactly (Sullivan 17:25).*

The point of this quotation is not to impugn the qualifications of this official, who according to Steiner’s criticism only exemplifies a broad effect on thought of the neglect of total volumes in managing stormwater.

It was another engineer who emphasized a distinction between *infiltration* and *groundwater recharge*:

Infiltration doesn’t mean groundwater recharge (Bannerman 44:06).

He was distinguishing between water that is *held* and eventually transpired by plants or evaporated from soils, and water that *passes through* soils, collecting as groundwater stores. Certainly in this report we have categorically failed to make use of such a distinction. However, to add this distinction would be in the spirit of the report, which has already emphasized the diversity of “infiltration” practices and the variety of reasons for it (for to take account of the distinction would only diversify our conception of such practices further, according to whether they achieved *infiltration* or *groundwater recharge*). Yet in a report already surcharged with the diversity of its subject matter, we suggest that this distinction would serve future research focused on a lesser number of practices. This lesser number might then usefully be distinguished according to Bannerman’s suggestion.

Further research

The need for further research is really on two levels. First, the research to which this report is the conclusion should be regarded as preliminary. It undertook to assess the social and institutional barriers to stormwater infiltration, which in retrospect was too broad a topic. Future research would benefit from narrowing its focus either to specific practices or barriers. We do feel the present study would serve as a useful point of departure for assessing which narrowed directions would be most fruitful. Second, this research is preliminary in that the situation in our primary study areas is rapidly changing. There are questions that can be asked today that could not be readily asked two years ago. The following suggestions for further research aim to exploit these new opportunities.

Focus groups with homeowners at Bielinski and Heffron subdivisions

Most of the subdivisions on which our interviews centered had not yet broken ground (or only minimally so) at the time of the interviews. As these subdivisions (those of Bielinski Brothers and Heffron & Associates) have now been built out and occupied, homeowners could now be approached for their reactions to and experience with rain gardens and other plat-scale infiltration practices. However, these units have only been occupied for about a year at most, and so whether to approach homeowners now or after more time has elapsed (or both) will depend on the specific research goals (*e.g.* whether maintenance is organized as it was described to us by the developers in the planning stage, the relative success of the various maintenance arrangements, homeowner reactions, etc.). One goal that could be pursued in the near term would be focus groups with homeowners centered on the kinds of issues that emerged from our focus groups in Maplewood, MN. These would include, first, whether homeowner aversion to standing water undermines acceptance of rain gardens. It did not among Maplewood residents. But as noted earlier in this report, the exemption of rain gardens from such an aversion among Maplewood homeowners may follow from the specific conditions under which rain gardens were introduced there. Second, a comparison could be made of homeowners' understanding of the functioning of rain gardens. In Maplewood, for instance, we repeatedly found confusion over functional aspects of the gardens. It would be useful to gauge whether similar confusion is present at the two Heffron subdivisions where rain gardens are incorporated.

Adjustments to new regional regulations

As noted on several occasions in the report, new regulations regarding infiltration were instituted both in Dane County and in the region covered by the Milwaukee Metropolitan Sewerage District. How these regulations have affected municipal practice would be a fruitful area of further research in light of our findings here on the importance of municipal ordinances and municipal officials. Following how municipalities have responded to these new regulations by way of interviews with municipal officials would also help rectify the under-representation of such officials in our initial interviews. At the time of our data collection, several municipalities had already undertaken substantial revision of their ordinances in directions affecting infiltration practices. Future research might also attempt a systematic assessment of trends in this regard, whether in connection with the new regional regulations just discussed or in connection with PUDs as an opportunity for municipal experimentation, as discussed earlier.

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An "*" denotes interviews that centered on specific developments in which infiltration practices are incorporated.

Appendix A

Understanding homeowner reactions to rain gardens: focus group reviews of the Maplewood Rainwater Garden Projects

Research conducted in cooperation between the City of Maplewood, the Maplewood Nature Center and the Wisconsin Department of Natural Resources.

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Introduction

The following report has been constructed from data gathered from two focus groups, held on Tuesday, May 21, 2002, at the Maplewood Nature Center in Maplewood, Minnesota. The focus groups were organized as a cooperative venture between staff from the City of Maplewood and the Wisconsin Department of Natural Resources. The focus groups served a dual purpose: they allowed the City of Maplewood to review recent stormwater projects involving rain gardens and they gave the Wisconsin DNR an opportunity to investigate how homeowners respond to the option of having rain gardens on their property. The Wisconsin DNR came to Minnesota for this investigation because there is as yet no comparable group of homeowners in Wisconsin.

Very little if any research has been conducted on the topic of how homeowners react to rain gardens. This paucity of research is a direct consequence of the fact that such gardens are so new. The only relevant research of which we are aware does not specifically address rain gardens (Nassauer, 1993). It speaks to how people perceive of different plant community arrangements. It may be useful for designing types of gardens to offer to homeowners. But it does not address the kinds of constraints our research has identified, with the exception of a slight overlap on the issue of people's relation to plants (whether or not they are gardeners in our case, "knowledge of indigenous plant communities" in Nassauer's case).

By contrast, the homeowners from which the present focus groups were drawn had direct experience with rain gardens being installed in their neighborhoods as part of larger projects encompassing road reconstruction and stormwater re-engineering. These neighborhoods were already fully developed long before the present projects were undertaken. Therefore, the rain

gardens at issue here are retrofits. This fact has both positive and negative aspects. On the negative side, much of the interest in rain gardens has focused on the feasibility of their installation in *new* developments. The results of the present study of rain garden installations in *existing* developments therefore will be limited in their applicability to new developments. On the positive side, the fact that the earliest widespread installation of rain gardens has occurred as retrofits may indicate a promising pathway for getting this new technology on the ground and through practical trials. Furthermore, our recent research indicates the existence of a variety of challenging barriers to the installation of rain gardens in new developments. Therefore, it would seem well-advised for research to go where the action is.

The strength of the present focus groups is that they bring to the table people who have had first-hand experience with rain gardens. That experience includes deciding whether to have such a garden, hands-on experience installing and tending the gardens, as well as practical interactions with the municipality—the City of Maplewood—that oversaw the project. Such interactions—whether with a municipality or other organized entity—are a crucial part of any attempt to bring rain gardens into operation in anything more than piecemeal fashion. The practical importance of such interactions adds to the value of the present research. Because the present report is intended in part to help the City of Maplewood improve its future performance on such projects, the analysis of this interaction has mainly addressed the strengths and weaknesses of the city’s program. The assessments of the city’s performance contained here are based on the judgments of city residents. Needless to say, these judgments may be more or less accurate. But regardless of their accuracy, they represent an indispensable perspective.

The first focus group was composed of residents who opted to have a rain garden

installed (hereafter referred to as “gardeners”). The second focus group was composed of those who refused a garden (hereafter “non-gardeners”).²³ Though the report is not organized around these separate groups, the comments of gardeners are distinguished from those of non-gardeners throughout.

The value of homeowner choice

By and large, the City of Maplewood let residents decide for themselves whether they would have a rain garden. There was general agreement (across gardeners and non-gardeners alike) that leaving the choice to homeowners was a valuable element of the program for several reasons. First, it brought a greater sense of buy-in among those who chose to have gardens. Second, residents roundly agreed that the gardens required too much homeowner care to be left to an unwilling homeowner. There were some exceptional instances in which homeowners got a garden either against their will or as a result of default in making a choice. Focus group participants claim that the result is an obvious lack of motivation, observable in delayed and low-quality planting, as well as lax maintenance. It was suggested that if a garden simply has to go in where it is unwanted, then use only low maintenance plants or leave it as a more familiar grassy swale. It was also suggested that the best approach is to avoid such situations altogether by working as hard as possible to get some definitive answer from every homeowner (1-33:22, 68:47).²⁴

²³There is one exception: one gardener accidentally attended the group of non-gardeners.

²⁴This and all subsequent citations are to time points in the original audio data. The first number indicates whether the data is from the first or second focus group. The second number indicates the time point in the audio data.

“Choice” functioned in these projects on more than one level; in addition to the choice of whether to have a garden, those who opted for a garden were presented with the choice of garden type: shade, low-maintenance, butterfly, etc. This second level of choice was also greatly appreciated by those who opted for gardens, especially those who already enjoyed gardening. When asked how important this choice was, the focus group participants responded all at once in a chorus of expressions such as “It was a very nice choice” and “Oh, it was very important” (1-10:34).

Predicting who will opt for a rain garden

Although leaving to residents the choice of whether to have a garden might appear to make impossible an initial prediction as to where and how many gardens would be installed, the focus groups indicate that at least three characteristics of residents may be relatively good predictors of who will opt for a garden: age, attitudes towards gardening, and whether a resident has a water problem on his or her property.

Age - Regarding age, there was an obvious difference in average age between our two focus groups, with the non-gardeners being on average noticeably older. This observation must, of course, be subject to the qualification that the focus groups were not designed to determine whether residents’ age predisposed them one way or another. This is a question suited to be answered by a survey. Nonetheless, the differences in average age between the focus groups was striking enough to warrant the importance of age as an initial hypothesis. Furthermore, one reason why older residents would be less inclined to opt for a garden is relatively common sense, and in fact came up repeatedly: older residents are disinclined to shoulder the additional

maintenance entailed by a garden (2-7:11,35:41,37:04,39:34).

Attitudes toward gardening are also apt to be useful tools to predict who will opt for a garden. Most of the participants in our group of gardeners characterized themselves as gardeners. What is more, they pointed to their avidity for gardening as one of the main reasons they opted for a garden (1-12:50). As one participant said:

I like gardening. I love working out in my yard, so it was added, you know, just a visual thing for me, which I like...(13:30).

Water problems—Lastly, residents who have experienced persistent water problems on their property—such as standing surface water or basement wetness—are apt to accept a rain garden. These are people who would likely be ready participants in almost any program. Among the focus group participants who had such problems, there was a sense of desperation that *something* be tried, a desperation having grown out of their own unsuccessful attempts to deal with such problems. As one participant described her experience:

...we have a large water problem in the back...Us being the lowest spot, we collected water from about five yards around us, so it was very frustrating on the heavy rains, we had the problems and nobody else did, which really was irritating, and you know, the City of Maplewood, you know, heard from us many times before this project even came through so we were happy to see something happen...(1-6:20; also 1-14:07).

Methodologically speaking, these three factors affecting residents' choices—age, attitudes towards gardening, and experience of water problems—bear emphasis because they are potentially accessible pieces of data that could be used in early planning stages to forecast the extent of acceptance of rain gardens in specific projects. It should be noted, however, that the Maplewood projects did not undertake such an assessment, nor should the present focus group experience be taken as establishing the on-the-ground workability or usefulness of such a preliminary prediction. It is noted here in a *hypothetical* spirit, as a *potential* tool whose practical merits can

only be gauged by actual trial. In addition, even were such a tool workable, it should be kept in mind that the resulting prediction would be *preliminary*, not only in the sense of being prior to the actual choices of residents, but also preliminary in the sense of *prior to any presentation of the gardens that might modify how residents assess them*. And as the next section notes, the focus groups reveal potentially fruitful means of convincing residents to opt for a garden.

Who wants a rain garden: a fixed constraint?

The City of Maplewood chose by and large to leave to homeowners the decision of whether to have a rain garden. As we have seen, focus group participants agreed with this approach for several reasons. However, homeowner choice thereby affects an important parameter in the engineering of a community stormwater system. Consequently, it bears emphasis that the question, “Who wants a rain garden?” should not be regarded as a question with an unalterable answer. A municipality contemplating stormwater system utilizing rain gardens could pose this question at the outset of a project and then ask that its engineers work within the confines of homeowner preferences. This approach may be a mistake. The focus groups indicate that in many instances residents are not initially aware of several points of view that might influence their choice, such that to pose the choice to them from the outset would squander the opportunity to expand the points of view impinging on homeowners’ choices. The focus groups indicate several of the vantage points that should be cultivated. These points of view share the general goal of getting participants to think beyond their own properties, to view their decision in relation to a shared problem.

The Maplewood projects in fact took some steps toward enlarging the perspective of

homeowners, notably by communicating to residents that infiltrating water locally would beautify the community and save the city money by reducing charges the city must pay for the volume of stormwater it contributes to the Battle Creek watershed. One focus group participant recalled this appeal, but thought it too distant to affect homeowner choices (1-77:53). However, participants found more persuasive the ideas of “helping your neighbor” and getting rid of standing water in the neighborhood (1-77:32).

The idea of helping your neighbor has deep roots in American practice and religious teaching. Of course, rain garden planners shouldn’t assume that a spirit of helping one’s neighbor is always and everywhere present. However, exchanges between Maplewood focus group participants indicated that what was often lacking was not a neighborly spirit but an understanding of how stormwater moved through the neighborhood, causing problems for some and sparing others. Those without water problems indicated being unaware of how water leaving their property affected others (1-74:12). In short, a neighborly spirit—even if present—is of little effect *unless residents understand how their decisions have consequences for their neighbors*.

This lack of understanding was exhibited both directly—when focus group participants acknowledged having not known what their neighbors suffered—and indirectly when participants discussed their decisions about a rain garden *solely in terms of whether they experienced problems on their property* (2-28:31,37:54). Another way of putting this point is that when residents understand the shared nature of the problem, they are more apt to regard the choice of whether to have a rain garden less as an individual choice. This observation is in no way meant to imply that individual choice be curtailed, only that individuals should be helped to make their choice in light of the shared aspects of the problem. One participant seems to have seen “her”

choice from such an extended or community point of view (1-32:08).

The elimination of standing water was noted as another community-level reason for participation in the garden program. Standing water on or next to the street was seen as damaging it and standing water anywhere was seen as breeding mosquitoes throughout the neighborhood (1-78:58). Both gardeners and non-gardeners agreed on the value of eliminating standing water.

On the subject of standing water, although the non-gardeners by definition did not have rain gardens installed on their properties, many still had some form of ditch or grassy depression. These ditches are apparently not draining as well as the rain gardens; only the non-gardeners complained of standing water as a problem persisting even after the project was completed (2-49:41,53:09).

A final reason why who wants a garden should not be regarded as having a fixed answer is the fact that hardly any of the focus group participants had any prior knowledge of rain gardens (2-19:51), and consequently had not had occasion to develop specific attitudes towards them. However, even when officials enjoy such a blank slate of prior experience, residents are still apt quickly to see the proposal of a rain garden in terms of something they already do know. Hence the strong tendency among both gardeners and non-gardeners to evaluate whether to have a rain garden on the basis of whether they saw themselves as gardeners and in terms of the work they associate with gardens generally, whether or not they had specific experience with a rain garden. Another instance of seeing the new idea of a rain garden in terms of something with which residents were already familiar was a fear that using rain gardens meant going back to roadside ditches, which had apparently been in use at an earlier time in one of the communities (1-15:45).

Each of the above points is noted as a potentially useful means to convince residents to choose to have a rain garden. They are ways of responding to what appears to be a common mode of reasoning against having a rain garden: I don't have a water problem, so I don't need a garden. This perspective should not be surprising; people are likely to think in terms of their own property, not only for the obvious reason that they care most about what happens in their basement but also because they may simply not be aware of the problems suffered by others. To the extent that the educational efforts undertaken at the outset of a project can cultivate a greater appreciation of the problems of others or of the community as a whole, the perspectives from which choices are made about rain gardens can become less individual even as they continue to be made by individuals. Lastly, a broadening of the perspective of individual choices might be most economically pursued if targeted at residents most likely to refuse gardens as identified by the three criteria mentioned earlier.

Living with a rain garden

The unique value of these focus groups is to tap into the experience of residents who have actually lived with and cared for a rain garden. Although none of our participants yet had more than a few years of such experience, they already have issues to report. The three main issues that surfaced were floating wood chips, maintaining the garden edge, and challenges associated with the slope of the gardens.

The problem of wood chips floating when the gardens fill—leaving a “bathtub ring” of chips when the water recedes and requiring that they be raked back in—has already been recognized by the city and has been solved through the use of *shredded* as opposed to *chipped*

wood.

The issue of maintaining the garden's edge was brought up as an important determinant of how the gardens look, as well as a technical challenge, especially when that edge is located where the garden slopes steeply, making mowing at the edge difficult (1-23:03; 2-47:18). When the issue of maintaining the garden edge came up, there was much exchange of tentative ideas among gardeners, indicating that they are very much still learning how to manage this aspect of the garden. In any case, it appears clear that the steeper the sides of the garden, the more pronounced these maintenance issues become. How, whether and to what extent to minimize the steepness of garden sloping is beyond the scope of the present research, but may be an important area for subsequent study, perhaps by those knowledgeable of the technical functioning of the gardens. Aside from these specific issues, residents who have lived with the rain gardens report that they do not take any more care than other types of gardens (1-49:53).

Although non-gardeners do not live with a rain garden in the sense of having to maintain one on their property, they do have to live with them as functional and aesthetic components of their neighborhood. The non-gardeners concede that the rain gardens function well (2-14:19, 48:53,50:58); most storm water problems have been eliminated and the gardens appear to perform as designed. However, non-gardeners are quick to criticize the gardens as eyesores, either because they are poorly maintained or because they collect trash. At the same time, they admit admiring some of the better maintained gardens (2-36:05) and that the gardens are not the only place litter collects (2-19:13). In any case, non-gardeners are not alone in criticizing poorly maintained gardens; gardeners share this concern. And participants from both groups agree that judgment should be withheld on the look of the gardens until some of the planting have time to

mature.

City performance

Overall, the city was roundly commended for how smoothly the whole process was conducted, especially how the city communicated with and treated residents during the process. This opinion was shared by gardeners and non-gardeners alike (1-28:49,57:46,70:40; 2-15:44,16:18,61:56,62:49). As one participant put it:

I just don't have any negatives. I think they [the City of Maplewood] did an excellent job...(1-70:45).

Another participant praised the city in the following terms:

When I call down there, I get results. I'm very grateful to Maplewood...I can't say enough about the engineers at Maplewood (2-16:17).

On the modes of communicating with residents

The city communicated with residents through mailings and community planning meetings. Focus group participants agreed that both these means of communication should be continued, each offering distinct benefits (1-71:18). Deep appreciation was also expressed for on-site visits made by city staff to help diagnose site-specific problems and to explain how the gardens would function (1-71:45). Focus group participants found the City of Maplewood responsive on virtually all counts.

Confusion over voting procedure

Though the planning meetings were deemed useful, participants expressed confusion

about the voting procedures that occurred at the community planning meetings, votes they understood to bear on whether the project as a whole would occur at all (2-24:41,65:24). This confusion was not adequately probed during the focus group sessions both because the focus groups were directed to issues immediately surrounding the rain gardens and because the moderator was not familiar with these general voting procedures as conceived by the city. Yet the issue was accompanied by sufficient emotion that it is noted here as one to which the city might want to address itself in the future. It should also be noted that this confusion only arose among the non-gardners.

One constructive suggestion was made regarding the planning meetings; these meetings might be supplemented by smaller group meetings on the model of the focus group sessions. Participants in the focus groups appear to have appreciated the opportunity for extended discussion offered by the focus group setting.

Initial presentation of rain gardens to residents

Focus group participants reported that the garden brochures, the planning meetings and the invitations to visit completed projects were all useful ways to be introduced to the gardens. Of course, not all municipalities will have the luxury of completed projects at hand for residents to see. But when such an option is available, residents appear quite eager to see an actual installation. If there be a shortcoming to such site visits, it is that residents are apt to appraise what they see only in aesthetic terms, for they are unlikely to visit during foul weather when the gardens are doing their work. Nor are they likely to appreciate the functional aspects of the gardens if they visit them unaccompanied by someone knowledgeable about their functioning.

Because functional misunderstandings of the gardens appear prevalent (these misunderstandings are detailed below), the question arises whether casual visits to existing gardens might not usefully be replaced or supplemented with guided tours, during which a functional appreciation of the gardens could be cultivated along with an aesthetic assessment. Of course, organizing such tours is an additional logistical task. Perhaps they could be scheduled prior to the community meetings about the projects. Or perhaps they could be “guided” in a looser sense; explanatory signs might be posted or brochures circulated that “guided” residents through the functional aspects of the gardens.

Keeping residents informed of what to expect

The rain gardens in Maplewood were installed during a period of road reconstruction. Such reconstruction unavoidably causes many headaches for homeowners, disrupting parking and access to one’s home, tearing up the front edge of yards, generating dust and mud, etc. As unavoidable as are these side-effects, our focus group participants broadly agreed that the City of Maplewood did an outstanding job of keeping residents informed of the progress of the project (1-9:58). The City was also commended for minimizing side-effects to the extent possible. So, for instance, the city was commended for watering down the roadbed to minimize dust and worked with residents to accommodate specific needs. The workmen were also praised for being considerate to residents (1-9:00).

You know, they were—ah, the workmen on the job—we have to say this: they were very considerate of the people who lived there...extremely considerate (1-9:00).

However, with specific regard to the raingardens, one important area of expectation management appears to have been overlooked; some residents were shocked when they saw how

deep were the garden excavations (1-22:19; 2-30:02). It appears that when residents envision the rain gardens, they envision them as they will appear in their final state, which is to say as relatively shallow depressions. But as the proper functioning of the gardens requires preparation of the area beneath the garden several times deeper than the final depression, some residents were aghast at the discrepancy between the shallow depression they had imagined and the yawning hole being dug in their front yard. In fact, one focus group participant who had initially opted for a garden changed his mind upon seeing the excavation:

When I first heard about it, I thought it was a good idea. As a matter of fact I wanted...two or three...because I have a long frontage. But then when I saw them digging and the depth they were going, that changed my mind (2-30:02).

This was the only focus group participant who definitively changed his mind about the garden during the course of the project.

Aid with the gardens

Those who chose gardens appreciated the various stages at which they were aided by the city, including (i) the selection of appropriate plants for their situation (1-10:42), (ii) aid in putting in plants (1-11:03), and (iii) the presence of a master gardener on planting day (1-60:13). They generally felt “there was lots of help” (1-36:03). The gardeners also found that the whole planting process was well organized and that they were kept informed where necessary (1-59:59,60:31). As one participant summarized it:

I thought the plant distribution went really well, too. It was all -- and they let us know ahead of time when it was going to be done, and how many you needed, and that was all really well done, I thought (1-59:59).

They also liked the range of gardens offered and the quality of the plants supplied, though some found the plants on the small side.

A suggestion was made that during the first summer following planting, guidance be offered during weeding in order that residents solidify their ability to distinguish garden plants from weeds. The problem here seemed to be a combination of inadequate experience with the plants concerned, as well as the small size of the original plants, making them more difficult to distinguish from emergent weeds (1-11:14).

Because so many of the non-gardeners said that it was the *maintenance* of a garden that deterred them from having one, they were asked a hypothetical question: “Would you have opted to have a garden had the city undertaken maintenance?” Some non-gardeners claimed they would have changed their decisions, others would not. This was the second of two hypothetical questions posed to non-gardeners. Recall that non-gardeners reported that water drained poorly from their grassy swales. They were asked whether they would have opted for a garden had they known that it would likely drain better than a grassy swale. *None* of the non-gardeners said this information would have changed their decision. This difference is an indication of the greater weight of maintenance issues; non-gardeners would surely have been happy to get rid of standing water and avoid moving muddy grass, but that benefit simply was not enough to overcome the anticipated burden of maintaining a garden.

Communicating how the gardens are to function

As has already been noted, the City of Maplewood was broadly credited with communicating well with residents about all manner of issues. Yet even such well-managed

communication clearly broke down in one major respect: communicating an understanding of how the gardens were to function. Points of misunderstanding included the following: the operation of the overflow drains, the sizing of the gardens (2-44:16,51:33,70:05), residence time of water in the gardens (2-30:22,48:09), the systematic connectivity of the gardens (1-39:46,41:20), etc.

The operation of the overflow drains was clearly the point of greatest confusion (1-20:26,73:38). Gardeners and non-gardeners alike found the elevated drain pipes violated common sense (1-20:26; 2-4:25,5:23,12:42); they expected a drain to be at the lowest point so the water would run out, as a bathtub or sink drain. The evident problem is that residents were interpreting the garden drains under a false analogy: the analogy is not with the main drain at the bottom of a sink or tub, but with the overflow drain located along the upper slope of a sink or tub. The presence and operation of such overflow drains in everyday living is likely overlooked by many, and so the false analogy to the main, bottom drain is quite understandable.

The functional misunderstanding was in some instances accompanied also by aesthetic dislike of the garden drains; being elevated, the drains are plainly visible and detract from the beauty of the gardens. The combination of misunderstanding and dislike of the drain poses the question of whether a different type of overflow drain design might address both problems at once: would it be possible to locate the drains flush with the ground, somewhere along the rising slope of the garden where it would serve its overflow function? The benefit of such a design would be not only to eliminate the drain as an eyesore, it would also put the drain in a position analogous to the customary position of an overflow drain in sinks or tubs, perhaps also making it easier for residents to correctly understand the drain's intended function. Whether by redesign or

by more explicit and insistent explanation, the focus groups indicate that this misunderstanding ought to be addressed.

The quality of sod

A very common complaint was that the sod supplied by the city was of poor quality. This complaint was voiced by gardeners and non-gardeners alike (1-26:42; 2-2:16,8:34, 15:26, 16:37). The sod was said to be full of crab grass and other weeds, and its installation sometimes left gaps and unevenness.

Although the sod might seem a relatively unimportant matter in reconstruction projects of such scope, it was nonetheless a significant source of dissatisfaction. Sod is after all a conspicuous finishing touch. Furthermore, one participant noted that he had been assured that his lawn would be “at least as good as it was before or better”. Violating such expectations deepened the dissatisfaction.

The potluck

Although some gardeners reported being too busy during planting day to attend the potluck, those who were able to attend (including non-gardeners) very much enjoyed the experience, especially getting to see neighbors they had not seen for a long time.

Future research: the problem of homeowner turnover

Only one of our gardens did not actually choose to have the garden; she inherited it when

she purchased the property. This class of persons will, of course, grow over time. And even though our single garden “inheritor” had much too narrow a base of experience to speak for this future group, several points arose that indicate some of the directions in which future research and planning will need to venture to address the specific challenges this group will present.

Such garden inheritors are more prone to misunderstand how the rain garden is supposed to operate on his or her property and how it is integrated into the community system of water management. So for instance, our garden inheritor misunderstood the intended function of the overflow drain; she did not understand that the drain was elevated intentionally so as to operate only when the water reached a designated level. She was not alone in this misunderstanding (pointing again to the general need to help residents understand how the gardens are to function). Nevertheless, this type of misunderstanding is surely more likely to arise among those who only come into connection with a garden by way of a home purchase. Concern was also raised that a new homeowner may not be as inclined to maintain a rain garden as the prior owner who expressly opted to have it (2-40:00). Even if they are inclined to maintain it, lack of understanding of the garden’s functioning may make new owners more liable to replace original plantings with plants unsuited to the growing conditions of the garden.

This brief list of issues that will arise with homeowner turnover must be regarded as largely incomplete and speculative. All that is sure is that this issue will loom progressively larger and will likely require new research efforts.

Conclusions

Prior to the present research, the City of Maplewood had already demonstrated the

feasibility of installing rain gardens into existing communities. This achievement is already an important finding for those concerned with practical ways to increase stormwater infiltration.

The Maplewood projects relied on voluntary acceptance of such gardens. The present research has helped determine what characteristics determine such acceptance: age, attitudes towards gardening, and whether a resident has a water problem. The first two of these constraints are beyond the influence of a municipality. Older residents in particular seem quite firm in their unwillingness to undertake maintaining a rain garden, not because they find them unattractive (they often do), not because they doubt the gardens' efficacy (they concede they work), but because they know the physical limitations of age and are determined not to overextend themselves. However, it was found that the last constraint is not fixed to the extent that residents can be encouraged to think beyond their own properties to shared problems, especially those impinging directly on their neighbors. How effective such an effort might be can only be determined by future attempts.

The decision in Maplewood to leave so much to homeowner choice did create a variety of logistical tasks, tasks which the city staff reportedly met with careful organization and open communication. Yet the persistence of misunderstandings, especially with respect to functional aspects of the gardens, points the way to remaining challenges. Among these challenges will be how to educate future homeowners about the gardens and to enlist their willingness to care for them. Our present research was only able to deal with this issue in the most preliminary and speculative of fashions.

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