MEMORANDUM

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FROM:	Dan Penrose, AICP Lisa Palazzi, CPSS, PWS Amy Head, PE, LEED AP BD+C
DATE:	October 5, 2015
PROJECT #:	0255.06
SUBJECT:	Advisory Committee Questions on Storm Pond, Wetlands and Flooding Frequency

At the September 10 Advisory Committee meeting, an issue was raised concerning the economic value of natural systems, and the use of urban forest within the study area of the New Market Industrial Campus and Tumwater Town Center. Specifically, a sheet was distributed to Advisory Committee members that asked four sets of questions regarding the frequency of flooding, high ground water hazards, benefits of wooded areas for stormwater treatment and infiltration, and other items. SCJ has explored these questions, reviewed existing research and, based on our analysis and understanding of the environmental characteristics of the site, provide the following response.

Literature Review

The Economic Value of Forest Ecosystem Services: A review, by Douglas Krieger PdD, 2001
http://www.sierraforestlegacy.org/Resources/Conservation/FireForestEcology/ForestEconomics/EcosystemServices.pdf

This review summarizes 56 other research studies that assess valuation of "natural forest ecosystems" with grouping into eight benefit categories, but most of the studies are based of very large forest ecosystems, wilderness areas; national forest, etc. One is about urban forests (Dwyer 1992); one is about benefits of open space (Lerner and Poole, 1999); one about placing value on planting urban trees (McPherson, 1992). Thus, out of 56 articles about valuation of forest lands, only three include assessments for valuing urban forests or benefits of trees in an urban area. In summary forest lands provide:

- Watershed services (water quantity and quality benefit) typically studied thousands of acres
- Soil stabilization and erosion control (localized; important near streams and other water bodies, but can achieve soil stabilization in other ways)
- Air quality (regionally important; trees do have a positive impact on air quality, but for great benefit, need a great number of trees)
- Climate regulation and carbon sequestration (regionally important; need large acreage)

- Biodiversity (natural and connected large ecosystems)
- Recreation and tourism (large forests; parks, etc.)
- Non-timber products
- Cultural values

Table 1. Range of Estimated Forest Ecosystem Service Values by Region

Ecosystem Service	Region					
	Entire United States	Rocky Mountains	Southeast	Pacific Northwest	Northeast	Southwest
Watershed services						
Quantity	$0.26 to $50.86/ acre-foot	$4.07 to $940/ acre-foot	$57/ household/ year			
Quality	$64.16/ house-hold/ year			$920,000 to $3.2 million/ year	$729,000 to $35 million/ year	
Soil stabilization			$1.94/ton	$5.5 million/ year		$90,000
Air quality						$4.16/tree (urban)
Climate regulation and carbon sequestration	$1 to $6 billion/ year					$20.75/tree (cost to cool buildings)
Biological diversity	$4 to $54 billion					
Recreation						
Economic impact	$1.3 to $110 billion (national forests)	$736 million (wilderness)	$6 billion (all) to $407 million (hunting)	$1 billion (fishing)		
Wilderness recreation	$600 million/ year	$14/ visitor day	$12/ visitor day		$29 million/ year	
Hunting and fishing		$2.07 to $12.3 million	$237 to $637 million			$13 to $25/ deer
Non-timber products			$300 million/ year			$910,000/ year
Cultural values						
Aesthetic and passive use	$280 million/ year	$14 to $92/ household/year	$12 to $99/ household/year	$48 to $144/ household/year	$4.5 to $167 million	
Endangered species	$2 to $3.7 billion/year			$15 to $95/ household/year		$40/house-hold/year
Cultural heritage						$4.5 million

Table 1 from Krieger 2001 study

Table 2. Estimates of forest ecosystem values

Ecosystem good or service	Market nature of service[a]	Global values by forest type ($/acre)[b]			Value of all U.S. forests[c] (billion $)
		All forests	Tropical	Temperate/ Boreal	
Climate regulation	NM	57.1	90.2	35.6	18.5
Disturbance regulation	NM	0.8	2.0	n.a.	n.a.
Water regulation	NM	0.8	2.4	0.0	0.0
Water supply	M,NM	1.2	3.2	n.a.	n.a.
Erosion control and sediment retention	NM	38.8	99.1	0.0	0.0
Soil formation	NM	4.0	4.0	4.0	2.1
Nutrient cycling	NM	146.1	373.1	n.a.	n.a.
Waste treatment	NM	35.2	35.2	35.2	18.3
Biological control	NM	0.8	n.a.	1.6	0.8
Food production	M	17.4	12.9	20.2	10.5
Raw materials	M	55.8	127.5	10.1	5.3
Genetic resources	M,NM	6.5	16.6	n.a.	n.a.
Recreation	M,NM	26.7	45.3	14.6	7.6
Cultural	NM	0.8	0.8	0.8	0.4
Total		392.1	812.2	122.2	63.6

Note: n.a. = not available.

[a] "NM" denotes a good or service that is primarily non-market in nature. "M" denotes a primarily market good or service. "M,NM" denotes a good or service that has significant market and non-market characteristics.

[b] Calculated from the $/hectare estimates of Costanza et al. (1997b) based on a conversion factor of 2.471 acres/hectare. All values are in U.S. 1994 dollars.

[c] Estimates for the United States were based on a total area of 520 million acres of temperate/boreal forest

Table 2 from Krieger 2001 study

Also reviewed were "The Effects of Trees on Stormwater Runoff", a February 2008 study conducted by Herrera Environmental Consultants for Seattle Public Utilities. The study addresses the use of conifer trees to help manage precipitation runoff and states that "it can be estimated that a conifer in the Pacific Northwest intercepts and transpires approximately 30 percent of the precipitation falling upon it." It reinforces the efforts that have been made in the planning process to retain more than 83 acres of forested area and large stands of fir trees throughout the NMIC study area.

Below are SCJ's responses to the questions posed in the handout:

Question

A. How do the benefits of flood protection currently provided by Tumwater's urban forest compare to the costs and benefits of storm ponds in the New Market area?

Response:
Per current stormwater code both for Western Washington and as applied by the City of Tumwater, using existing vegetation for stormwater management rather than using a designed stormwater facility is called "full dispersion". The code requires 65% of the site to remain undeveloped in order to meet the requirements for full dispersion. Therefore, under a best case scenario, if one were to use the forested areas in the NMIC to receive, treat and infiltrate stormwater runoff (rather than a designed stormwater facility), only about 190 acres of the 550 acres could be developed. Unfortunately, as evidenced by the flooding experienced in the late 1990s, dispersion of stormwater to surrounding urban forests does not provide sufficient flood protection to allow for proposed development of NMIC. The cost of the storm ponds is offset and paid for by the profits from creating new business opportunities in the NMIC.

In the context of developing a regional stormwater management system, a storm pond is designed to mimic the predevelopment, forested condition, thus should not result in more flooding. The system can be designed to *reduce* flood impacts by directing excess runoff toward deeper and more permeable soils in the NMIC. Under that circumstance, flood damage relative to the current condition may be decreased with proper regional design, and allow more development of the 550 acres. The cost of the ponds would be relatively minor compared to the value of the developable land and new business opportunities.

Question

B. Is it possible for the storm ponds to provide ecosystem services equivalent to those currently provided by the forest? At what cost?

Response:
Although the scientific research on using forests to provide stormwater treatment and storage function is limited, it is evident from the literature reviewed that intact natural forests are adept at capturing precipitation, providing flow control and some treatment prior to rainfall leaving the site. This does have an economic value compared to a constructed system in the context of large scale forested lands or wilderness. As cited above, all but three of the 56 studies in the 2001 Krieger report were on sites with many thousands of acres of intact forest, and comparisons are difficult draw to the NMIC study area where there are groupings of trees and vegetation from 5-20 acres in size.

Growth Management Act (GMA) regulations does provide guidance on how to develop within our urban cores, which is done only after setting aside Critical Areas and their buffers – wetlands, streams, steep slopes etc. for our enjoyment, and to ensure that we retain some wildlife habitat and functions within our urban areas. The philosophy behind GMA is to focus dense development and industry within urban areas, and thereby preserve valuable habitats that require more expanse and connectivity outside of urban areas. In GMA, urban forests were not defined as Critical Areas, partly because a functional forest ecosystem needs to be quite large, and on average, the animals using a forested ecosystem are also relatively large, and need a large territory or range compared to animals that live in and near wetlands and streams. For that reason, forested systems were not given this kind of protection through GMA in urban and industrial areas because in order to preserve opportunities for those large habitats in rural areas.

We do know that stormwater facilities can be designed to mimic forested areas and wetlands in their appearance and function, and many stormwater ponds quickly become critical urban habitats for animals requiring ponded water for some portion of their life cycle. A wetland's functions and values are not the same as a forest, but the wetland habitat is more suited to urban settings. Particularly in the NMIC study area, there are few functional wetland systems. Thus, designing stormwater facilities to provide those functions and habitats in the NMIC may prove to be more valuable than preserving a marginally functional, small forest ecosystem. There are forested areas nearby, outside of the densely developed industrial port area, which will be safer for the animals living there, and more in keeping with requirements of a functional forest ecosystem.

Question

C. Is the 1999 flood event a worst-case scenario, or can we reasonably expect worse flooding events in the future? Rising global temperatures accelerate the hydrological cycle; this can worsen droughts and cause more severe heavy rainfall periods. How may that dynamic impact future flooding in our study area?

Response:
The 1999 event was from groundwater flooding – i.e., a series of unusually high rainfall events that caused the regional water table to rise over a long period of time, starting as early as the 1997 winter. It takes an almost perfect series of weather events to create this condition, and for that reason, we know that groundwater flooding will be relatively rare. Never the less, we must plan for it, and adjust site design accordingly. But it is important to note that once the groundwater reaches the surface, it drains away and cannot rise much higher. Therefore, even if we have more groundwater flooding events in the future, the height of the water surface – i.e., flooding elevation -- is unlikely to be higher. The purpose of a regional stormwater system design will be to help reduce flooding during those unusual events – to design buildings and related infrastructure that will be higher than the flood elevation, and to redirect water under controlled conditions to areas better able to infiltrate and drain. We know that the groundwater flow direction is to the north, and therefore, groundwater flooding will be directed toward facilities in the north.

Question

D. What does it mean to call the 1999 flood a 100-year event? Such events are projected to occur considerably more often now. Two strong La Nina years could produce another such event in the current decade.

Response:
The 1999 event was an extreme outcome to a series of extreme events, and we cannot predict when those events occur. We can only assess what we know based on historic data. For that reason, we no longer define storms as "100-year events", but we still use that terminology as it represents the concept of the "less than 1% chance of re-occurrence in any given year". Now we model stormwater facility design based on documented, historic rainfall events, and with that design, we ensure that the stormwater facility can manage anything comparable to those historic events to a certain level. We cannot design to every eventuality, so we design to what we currently have determined to be an acceptable level of risk, and based on the requirements of the stormwater manual. As time goes by, if conditions (and regulations) change, we will change our measurement of the level of risk.

Other items:

The handout included numerical values for ecosystem and economic services associated with a forest ecosystem, and a parallel was drawn between the previously analyzed Capitol Forest and the standing trees and wooded are in the NMIC study area. As with any analysis, it is important to clearly define what kind of "forested ecosystem" was studied to provide the basis of this valuation. The semi-isolated patches of forest plant communities within the NMIC provide some forest habitat, but cannot be characterized as intact and connected forest ecosystems, and do not have the same "living forest" ecologic or economic value as, for example, those in the Capital Forest or other DNR or USFW-owned forest lands.

For that reason, before simply applying these values, it would be useful to have background information that describes how these values were assigned and what forests were used to create the value matrix. Otherwise, it is difficult to assess and compare the value of the alternative, which is a developed industrial park (economic services) with regional stormwater facilities that also provide wetland habitat (ecosystem services). These forest ecosystem services are recognized by various federal agencies, but are typically assigned to large federally-owned or privately owned managed forests – not to small pockets of forest land in urban areas. That does not mean that forest lands are not valued within our urban areas, but these areas are typically set aside as park land and not within an industrial park which has increased liability and danger associated with providing areas for recreational public use.

Additionally, the discussion on Salmon Creek Basin is not directly applicable, as the majority of the NMIC study area is not within the Salmon Creek Basin, the flow pathway shows that groundwater is mounded with flow direction to the NW, N and NE, away from the Salmon Creek neighborhood, and that it in fact does not have a "bowl-shaped local hydrogeology". That description applies to areas to the south outside of the study area.